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(54) Apparatus and process for reagent fluid dispensing and printing.

(57) A system for printing and dispensing chemical reagents in precisely controlled volumes onto a medium at a precisely controlled location. A jetting tube, comprising an orifice at one end and a fluid receiving aperture at the other end, is concentrically mounted within a cylindrical piezo-electric transducer. The fluid receiving aperture is connected to a reservoir containing a selected reagent by means of a filter. The reservoir is pressurized by a regulated air supply. An electrical signal of short duration is applied to the transducer. The pulse causes the transducer and the volume defined by the jetting tube to expand, thereby drawing in a small quantity of reagent fluid. The cessation of the pulse causes the transducer and the volume of the jetting tube to de-expand, thereby causing at least a substantially uniformly sized droplet of reagent fluid to be propelled through the orifice. The droplet may be directed to impact a printing medium or collected in a dispensing recepticle.

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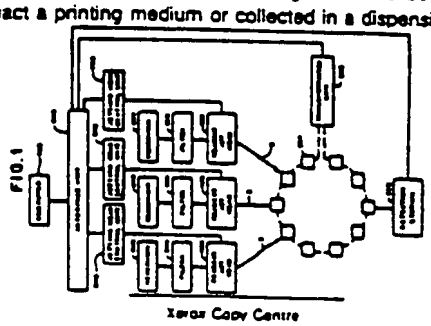

FIG.1

count down inputs CU, CD of the counter U24 by means of opto-isolators U19, U20. The carry and borrow outputs CY, BR of the counter U24 are connected with the count up and count down inputs CU, CD of the counter U25. The reset inputs RST of both counters U24, U25 receive the RST signal by means of an opto-isolator U21. Resistors R16, R17, R18 are used as load resistors for the LED circuits of the isolators U19, U20, U21 and capacitors C26, C27, C28 are used to enhance the stability of the isolator circuits.

The counters U24, U25 may optionally be preloaded to the selected 8-bit binary value through input lines TP0-TP7. The input lines TP0-TP7 are normally biased to the logical high signal state by resistive network U22. The selected binary value is loaded into the counters U24, U25 by pulling the respective inputs TP0-TP7 low and applying an external, active low, load signal EXT LOAD to pin TP8. The load signal pin TP8 is connected to the load inputs LOAD of the counters U24, U25 and conditioned by a clipping circuit comprised of diodes CR9, CR10 and a pull-up resistor of the resistor network U22.

The noninverted and the inverted outputs IOUT, IOUT* are connected to the inverting and noninverting inputs of a differential amplifier U29. The output of the amplifier U29 is fed back to the inverting input by a resistor R50. The amplifier U29 converts the current output of the D/A converter U30 to a voltage output. Capacitors C56, C47 are provided to enhance circuit stability.

The output of the amplifier U29 is applied to the noninverting input of the amplifier U28. The output of the amplifier U28 is fed back to the inverting input by means of a capacitor C46 and a resistor R37. The inverting input is also connected to ground by a resistor R36. To enhance the frequency response of the amplifier U28, a resistor R43 and a capacitor C54 are connected between the frequency compensation input FC and ground. An adjustable DC offset is provided by connecting the output offset inputs OF, OF with a variable resistor R42. The wiper of the resistor R42 is connected to the high voltage power supply output V+ +.

The output of the amplifier U28 is also connected to the base of a transistor Q4 and through diodes CR11, CR12 to the base of a transistor Q7. The transistor Q4, Q7, Q3 and resistors R30-R35 form an output circuit capable of driving high capacitive loads at high slew rates and wide bandwidth. The variable resistor R31 may be used to set the maximum current through the bias network R30, R33 by measuring the voltage drop across resistor R35.

The strobe generator 560 produces a strobe pulse and comprises transistors Q101-Q105 and a one-shot circuit U108. The strobe intensity is determined by the circuit comprising the transistors Q101-Q104 and resistors R109-R115. The circuit is connected to the anode of the LED 900 and receives two inputs from the interface unit 600 to produce four levels of light intensity in the LED 900.

The activation aand duration of activation of the LED 900 is determined by the one-shot U108 and the transistor Q105. The one-shot U108 comprises inputs A, B and an output Q. The strobe signal STROBE is applied to the B input from the interface unit 600. The duration of the one-shot U108 output pulse is controlled by the adjustable RC network R107, R108. The output Q is applied to the base of the transistor Q105 by resistor R108. The collector of the transistor Q105 is connected to the cathode of the LED 900 to draw current through the LED 900.

The computer 700, control unit 500 and plotter 800 must be initialized. The initialization of the computer 700 and the plotter 800 will not be discussed since these units are of conventional design and operation.

To initialize the jetting head control unit 500, the computer 700 directs the interface unit 600 to issue a reset command. The reset signal RST is conducted to the control unit 500 whereupon the counters U24, U25 are cleared. The computer 700 then retrieves from its memory, or by conventional operator input, the desired digital setting for the D/A converter. This setting may also be calculated from data and may be tailored to specific sizes of jetting heads 400 or reagent fluids. The computer 700 then issues a series of commands, through the interface unit 600, to increment or decrement the counters U24, U25 to correspond to the desired binary setting. If the command directs that the counters are to be raised, then the HIGHER* signal is applied through the opto-isolator U20 to the count up CU input of the counter U24. Similarly, if the command directs that the counters are to be lowered then the LOWER* signal is applied through the opto-isolator U19 to the count down CD input of the counter U24. Since the carry and borrow outputs CY, BR of the counter U24 are connected to the count up and count down inputs CU, CD, respectively, of the counter U25, the digital setting applied to the D/A converter U30 may range from 0 to 255. Alternately, the counters U24, U25 could be initialized to a desired setting by loading the binary value on the lines TP0-TP7 and strobing the EXT LOAD line.

Once the control unit 500 and the plotter 800 are initialized, the printing cycle may begin. The computer 700 issues a command to the interface unit 600 to produce the series of PRT* signal pulses. The computer 700 then commands the plotter 800 to print, for example, a line along a selected path. The plotter 800 positions the jetting head 400 and target 1 and issues the pen down signal PENDN. The signal is delayed by the print control circuit 510 to ensure that the target 1 is properly positioned. At the expiration of the

APPARATUS AND PROCESS FOR REAGENT FLUID DISPENSING AND PRINTING

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus and process for dispensing and printing reagent fluids, wherein a transducer is used to propel small quantities of the fluid towards a positioned target.

Diagnostic assays often require systems for metering, dispensing and printing reagent fluids. In the case of metering and dispensing, such systems comprise both manual and automatic means. For purposes of practicality, the present background discussion will focus on the methods of metering and dispensing 100 micro-liter volumes or less.

The manual systems of metering and dispensing include the glass capillary pipet; the micro-pipet; the precision syringe; and weighing instruments. The glass capillary pipet is formed from a precision bore glass capillary tube. The pipet typically comprises a fire blown bulb and a tubular portion fire drawn to a fine point. Fluid is precisely metered by aspirating liquid through the tube into the bulb to a predetermined level indicated by an etched mark. The fluid may then be dispensed by blowing air through the tube.

The micro-pipet typically comprises a cylinder and a spring loaded piston. The travel of the piston is precisely determined by a threaded stop. The distance the piston travels within the cylinder and the diameter of the cylinder define a precise volume. The fluid is aspirated into and dispensed from the micro-pipet in precise quantities by movement of the piston within the cylinder.

The precision syringe generally comprises a precisely manufactured plunger and cylinder with accurately positioned metering marks. The fluid is introduced into and dispensed from the syringe by movement of the plunger between the marks.

Weighing techniques for dispensing fluids often simply involve weighing a quantity of fluid. The density of the fluid may then be used to determine the fluid volume.

Exemplary automatic metering and dispensing systems include the precision syringe pump; the peristaltic pump; and the high performance liquid chromatography (HPLC) metering valve. The precision syringe pump generally comprises a precision ground piston located within a precision bore cylinder. The piston is moved within the cylinder in precise increments by a stepping motor.

The peristaltic pump comprises an elastomeric tube which is sequentially pinched by a series of rollers. Often the tube is placed inside a semi-circular channel and the rollers mounted on the outer edge of a disc driven by a stepping motor. The movement of the rollers against the tubing produces peristaltic movement of the fluid.

The HPLC metering valve comprises a defined length of precision inner diameter tubing. The fluid is introduced into the define volume of the tubing with the valve in a first position and then dispensed from the tubing when the valve is placed in a second position.

All of the above metering and dispensing systems have the disadvantage that the volumes dispensed are relatively large. Furthermore, these systems are also relatively slow, inefficient and comprise precision fitted components which are particularly susceptible to wear.

The printing of reagent fluids is frequently required in the manufacture of chemical assay test strips. Selected reagents are printed in a desired configuration on strips of filter paper. The strips may then be used as a disposable diagnostic tool to determine the presence or absence of a variety of chemical components.

Generally, to perform a chemical assay with a test strip, the strip is exposed to a fluid or a series of fluids to be tested, such as blood, serum or urine. In some instances, the strip is rinsed and processed with additional reagents prior to being interpreted. The precise interpretation depends on the type of chemical reactions involved, but it may be as simple as visually inspecting the test strip for a particular color change.

The manufacture of test strips generally involves either a manufacturing process or a blotting process. The blotting process is the simplest manufacturing method and permits most reagents to be applied without modification. A disadvantage of this process is that it is difficult to blot the fluids onto the test strip with precision.

The printing process will often involve any of three well known methods: silk screening; gravure; and transfer printing. The silk screening of reagents generally involves producing a screen by photographic methods in the desired configuration for each reagent to be printed. The screen is exposed under light to a preselected pattern and then developed. The areas of the screen which are not exposed to light, when developed, become porous. However, the areas of the screen which have been exposed to light remain relatively nonporous. The screen is then secured in a frame and the test strip placed below. The desired

reagent fluid, specially prepared to have a high viscosity, is spread over the top side of the screen. The reagent passes through the porous areas of the screen and onto the test strip. The test strip is then subjected to a drying process, specific to each reagent. Once the test strip is dry, it may be printed again using a different screen, pattern and reagent.

The gravure method of printing reagents comprises coating a metal surface with a light sensitive polymer. The polymer is exposed to light in the desired predetermined pattern. When developed, the polymer creates hydrophilic and hydrophobic regions. The reagent is specially prepared such that when applied to the metal it will adhere only to the hydrophilic regions. After the specially prepared reagent is applied, the test strip is pressed against the metal and the reagent is transferred from the metal to the test strip.

The transfer printing method comprises transferring the reagents from a die to the test strip in the desired pattern. The die is made with the appropriate pattern on its surface and then coated with the desired, specially prepared reagent. A rubber stamp mechanism is pressed against the die to transfer the reagent in the desired pattern from the die to the rubber stamp. The rubber stamp is then pressed against the test strip to transfer the reagent, in the same pattern, to the test strip.

Each of the above-mentioned reagent printing techniques has significant disadvantages. The most common disadvantage is the requirement that the reagents must be specially prepared. Additionally, if a variety of reagents are to be printed onto a single test strip, the strip must be carefully aligned prior to each printing. This alignment procedure increases the cost and decreases the throughput of the printing process. Moreover, a special die or screen must be produced for each pattern to be printed. A further disadvantage arises in that the above printing methods are unable to place reproduceable minute quantities of reagent on the test strip.

It is an object of the present invention to provide a printing and dispensing method and apparatus which avoids these disadvantages.

SUMMARY OF THE PRESENT INVENTION

The present invention is directed to a reagent dispensing and printing apparatus and method, wherein the apparatus comprises a transducer operative to eject a substantially uniform quantity of reagent in a precise predetermined direction.

According to one preferred embodiment of the present invention used in dispensing reagent fluids, a jetting tube is concentrically located with a piezoelectric transducer. The jetting tube comprises an orifice at one end and a reagent receiving aperture at the other end. The receiving end of the jetting tube is connected to a filter which is in turn connected to a reservoir containing a selected reagent. A jetting control unit supplies an electrical pulse of short duration to the transducer in response to a command issued by a computer. The electrical pulse causes the volume defined by the jetting tube to expand by an amount sufficient to intake a small quantity of reagent fluid from the reservoir. At the end of the pulse duration, the transducer de-expands propelling a small quantity of the reagent fluid through the orifice and into a fluid recepticle. If desired, additional droplets may be deposited in the recepticle or the recepticle aligned with an additional jetting tube for receiving an additional reagent fluid.

An additional preferred embodiment of the present invention may be used for printing reagent fluids onto a print medium. In this embodiment, the jetting tube is aligned with the printing medium such that the propelled droplet impacts a precise position on the medium. The jetting tube or print medium may then be repositioned and another droplet expelled from the jetting tube. The process may be repeated until a desired configuration of the reagent fluid is printed on the medium.

One advantage of the present invention is that precise minute quantities of reagent fluid may be dispensed or printed in a reproducible manner. Additionally, the method and apparatus may be used to emit droplets of fluids having a wide range of reagent fluid viscosities and surface tensions. The reagents do not in general have to be specially adapted for use with the present invention.

The invention itself, together with further objects and attendant advantages, will best be understood by reference to the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic representation of a first preferred embodiment of the present invention showing the use of multiple jetting heads to meter and dispense reagent fluid.

FIGURE 2a is a perspective view of a first preferred embodiment of the jetting head of the present invention.

FIGURE 2b is a cut-away perspective view of the preferred embodiment of Fig. 2a taken along lines 2b-2b with the contact pins removed.

FIGURE 2c is a sectional representation of the preferred embodiment of Fig. 2a taken along lines 2c-2c.

FIGURE 2d is a sectional representation of the preferred embodiment of Fig. 2c taken along lines 2d-2d.

FIGURE 2e is a sectional representation of the jetting tube and transducer of the preferred embodiment of Fig. 2b taken along lines 2e-2e.

FIGURE 3 is a schematic representation of a second preferred embodiment operating in the drop on demand mode as a reagent printing system.

FIGURE 4 is a schematic representation of a third preferred embodiment operating in the continuous mode as a reagent printing system.

FIGURE 5a is a schematic representation of a portion of the jetting head control unit showing the LED strobe circuit.

FIGURE 5b is a schematic representation of a portion of the jetting head control unit showing the high voltage power supply circuit.

FIGURE 5c is a schematic representation of a portion of the jetting head control unit showing the print control circuit.

FIGURE 5d is a schematic representation of a portion of the jetting head control unit showing a portion of the print pulse generator.

FIGURE 5e is a schematic representation of a portion of the jetting head control unit showing an additional portion of the pulse generator.

FIGURE 6a is a perspective view of a second preferred embodiment of the jetting head of the present invention.

FIGURE 6b is an exploded view of the preferred embodiment of Fig. 6a.

FIGURE 7 is a sectional representation of a third preferred embodiment of the jetting head of the present invention.

FIGURE 8 is a sectional view of a symmetrical portion of a fourth preferred embodiment of the jetting head of the present invention.

FIGURE 9 is a graph of the drop mass of the emitted droplets as a function of emission frequency for several fluid viscosities.

FIGURE 10 is a graph of the velocity of the emitted droplets as a function of frequency for several fluid viscosities.

FIGURE 11 is a graph of the total weight of fluid emitted as a function of the number of emitted droplets for a given fluid.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Turning now to the drawings, Fig. 1 shows a schematic representation of a first preferred embodiment of a reagent dispensing system generally represented as reference numeral 30. The dispensing system 30 comprises a plurality of reagent fluid reservoirs 200, a plurality of filters 300, a plurality of reagent jetting heads 400, a plurality of jetting head control units 500, an interface unit 600, a computer 700, transportation unit 902, a plurality of fluid mixing cells 904 and a detection station 906.

The reservoir 200 holds a selected quantity of reagent fluid for dispensing. The reservoir 200 is maintained at atmospheric pressure by suitable means such as an atmospheric vent. The reagent fluid is transferred from the reservoir 200 through the filter 300 to the reagent jetting head 400. The filter 300 is placed between the reservoir 200 and the jetting head 400 to ensure that any particular foreign matter in the reagent fluid is trapped before entering the jetting head 400.

The plurality of jetting heads 400 and the detection station 906 define a processing path. Each jetting head 400, which is described in detail below, ejects uniformly sized droplets 2 of reagent fluid. The droplets 2 are propelled, with controlled velocity and direction, towards a selecting mixing cell 904 positioned along

the processing path by the transportation unit 902. The mixing cells 904 are comprised of non-reactive material and function as minute holding tanks for the dispensed reagent fluid.

The plurality of jetting heads 400, shown in Fig. 1, are positioned sequentially along the processing path. Alternately, some or all of the plurality of jetting heads 400 may be positioned with respect to the transportation unit 902 such that the heads 400 direct the droplets 2 into a selected mixing cell 902 simultaneously.

The jetting heads 400 and the transportation unit 902 are controlled by the computer 700. The computer 700 issues commands to an interface unit 600 which is electrically connected to the transportation unit 902 and to the jetting head control unit 500. The interface unit 600 is of conventional design and is used to control the transfer of information between the computer 700 and the jetting control unit 500. The interface unit 600 is also used to control the transfer of information between the computer 700 and the transportation unit 902.

A first embodiment of the reagent jetting head is shown in Figs. 2a - 2e and generally represented by numeral 400. The jetting head 400 comprises a two piece symmetrical housing 402, 404. The housing 402, 404, when assembled, is adapted to form an orifice aperture 406, an air vent and reagent supply channel 410 and a transducer chamber 403, shown in Fig. 4b. Four screws 408, adapted to respective housing screw apertures 416, hold the housing 402, 404 in an assembled configuration.

The jetting head 400 further comprises a jetting tube 432, a piezo-electric transducer 434 and a reagent fluid supply tube 430. The jetting tube 432 defines a tapered orifice 433 at one end and a fluid receiving aperture 431 at the other end for expelling and receiving fluid, respectively. The piezo-electric transducer 434 is cylindrically shaped and secured concentrically about the mid-region of the jetting tube 432 with epoxy or other suitable means.

The piezo-electric transducer 434, shown in Fig. 2e, defines a first and second end and comprises a section of cylindrically shaped piezeo-electric material 435. An inner nickel electrode 437 covers the inner surface of the cylinder 435. The electrode 437 wraps around the first end of the cylinder 435 a sufficient distance to enable electrical connection external to the cylinder 435.

A second nickel electrode 436 covers the majority of the outer surface of the cylinder 435. The second electrode is electrically isolated from the first electrode 437 by an air gap at the face of the second end of the cylinder 435 and by an air gap on the outer surface of the cylinder 435 near the first end. When an electrical pulse is applied to the first and second electrodes 437, 436 a voltage potential is developed radially across the transducer material 435. The voltage potential causes the radial dimensions of the transducer 435 to change, which causes the volume defined by the transducer 434 to also change.

The jetting tube 432 is positioned in the transducer chamber 403 such that the receiving end 431 extends beyond the rearward end of the transducer 434. The receiving end 431 of the jetting tube 432 is inserted into one end of a reagent supply tube 430. The supply tube 430 is sealingly held to the jetting tube 432 by concentric teeth 412 formed by the housing sections 402, 404. The teeth 412 not only seal the supply tube 430 to the jetting tube 432, but, also, seal the supply tube 430 to the housing 402, 404.

The second end of the supply type 430 passes through the channel 410 and into a reagent reservoir 200. The reservoir 200 contains the reagent fluid to be dispensed by the jetting head 400. As the reagent fluid is dispensed, air is supplied to the reservoir 200 through the channel 410 to prevent the creation of a vacuum in the reservoir 200. The reservoir 200 is releasably attached to the housing 402, 404 and held in place by frictional forces. A reservoir cap 202 is flexibly attached to the reservoir 200 and adapted such that the cap 202 may be used to secure the opening in the reservoir 200 when the reservoir 200 is disengaged from the housing 402, 404.

The position of the jetting tube 432 defines the horizontal plane of the jetting head 400. The jetting tube 432 and the transducer 434 are held in a pre-defined vertical relationship with respect to the housing 402, 404 by means of two upper vertical alignment pins 418 and two lower vertical alignment pins 418. The two upper vertical alignment pins 418 extend horizontally from the housing section 402 into the transducer chamber 403. Similarly, the two lower vertical alignment pins 418 extend horizontally from the housing section 404 into the transducer chamber 403. Each vertical alignment pin 418 is formed integrally with the respective housing sections 402, 404.

The jetting tube 432 and the transducer 434 are held in a predefined horizontal relationship with respect to the housing 402, 404 by means of four horizontal alignment pins 424. Two of the horizontal alignment pins 424 extend horizontally from the housing section 402 approximately midway into the transducer chamber 403. Similarly, two of the horizontal alignment pins 424 extend horizontally from the housing section 404 approximately midway into the transducing chamber 403. Each horizontal alignment pin 424 is formed integrally with the respective housing section 402, 404. The alignment pins 418, 424, sealing teeth 412 and orifice aperture 406 are aligned and adapted to hold the jetting tube 432 and transducer 434 such

that the orifice 433 of the jetting tube 432 extends into the orifice aperture 408.

An electrical transducer activation pulse is supplied to the piezo-electric transducer 434 from the jetting head control unit 500 by means of two contact pins 422. A quantity of fluid will be dispensed from the jetting tube for each applied activation pulse. The activation pulse can be produced by a variety of conventional circuits or commercially available units. Therefore a detailed description of such a circuit will not be provided. However, a circuit for producing a series of activation pulses is provided in the description of the printing embodiment below. Due to the differing constraints involved in dispensing and printing, the circuit in the printing embodiment is not required to produce only a single pulse. However, one skilled in the art could, if desired, modify the circuit to produce a single pulse on demand for use in the dispensing embodiment.

Each contact pin 422 defines an enlarged head 423 which is adapted to contact the respective first and second electrodes 437, 436 located on the outer surface of the transducer 434. Two contact pin holders 414, integral with the housing 402, 404, are positioned to hold the respective contact pins 422 under the pin heads 423 such that each pin head 423 electrically engages the appropriate electrode 437, 436 of the transducer 434. Two contact pin engaging posts 420 extend from the housing 402, 404 opposite the contact pin holders 414 to engage and hold the contact pins 422 against the contact pin holders 414. The ends of the contact pins 422 opposite the pin heads 423 extend through the housing 402, 404 by means of contact pin apertures 421. Since the housing sections 402, 404 are formed symmetrically to one another, the contact pins 422 may be optionally attached above the transducer 434.

In operation, the reservoir 200 containing reagent fluid is fastened to the jetting head 400 such that the fluid supply tube 430 extends into the reagent fluid. The filter 300 may be fitted to the free end of the supply tube 430 or positioned inside the reservoir 200. Air is supplied through the channel 410 around the supply tube 430 to prevent the reservoir 200 from falling below atmospheric pressure. The air is prevented from entering around the supply tube 430 and into the transducer chamber 403 by the seal created between the sealing teeth 412 and the supply tube 430. The jetting tube 432 may be primed by slightly pressurizing the reservoir 200 to cause the reagent fluid to travel through the supply tube 430 and into the jetting tube 432. Once primed, the fluid is prevented from substantially withdrawing from the jetting tube 432 by the surface tension of the reagent fluid at the orifice 433.

The transducer activation pulse is conducted to the contact pins 422 of the jetting head 400. The contact pins 422 communicate the high voltage pulse to the electrodes 437, 436 of the transducer 434 with polarity such that the concentrically mounted transducer 434 expands. The rate of expansion is controlled by the rise time of the high voltage pulse which is preset to generate a rapid expansion. The expansion of the transducer 434 causes the jetting tube 432, which is epoxied to the transducer 434, to also expand. The expansion of the tube 432 generates an acoustic expansion wave interior to the tube 432 which travels axially towards the orifice 433 and towards the fluid receiving aperture 431. When the expansion wave reaches the orifice 433, the reagent fluid is partially drawn inwardly. However, the surface tension of the fluid acts to inhibit substantial inward fluid movement.

When the expansion wave reaches the end 431 of the tube 432, the expansion wave is reflected and becomes a compression wave which travels towards the center of the piezo-electric tube 434. The high voltage pulse width is adapted such that when the reflected compression wave is beneath the piezo-electric tube 434, the high voltage pulse falls, resulting in a de-expansion of the transducer 434 and the jetting tube 432. This action adds to the existing acoustic compression wave in the interior of the jetting tube 432. The enhanced compression wave travels toward the orifice causing reagent fluid to be dispensed from the tube 432. The fluid is propelled from the orifice 433 as a small droplet 2 and deposited in the selected mixing cell 904 positioned by the transportation unit 902. One droplet 2 is dispensed for each transducer activation pulse. This mode of dispensing is referred to as the drop on demand mode.

In some instances, the droplet 2 may be accompanied by at least one smaller satelite droplet. However, even if satelite droplets are present, the volume and velocity of the reagent droplets 2 are highly reproduceable. This reproduceability allows for precise dispensing of uniform, controllably sized droplets 2 of reagent fluid into the mixing cell 904.

The droplets 2 of reagents impact the mixing cell 904 with sufficient force and volume to cause fluidic mixing of the reagents. Once the desired amounts of the selected reagents are deposited in the selected mixing cell 904, mixing cell 904 is transported to the detection station 906 where the mixed reagents may be extracted for use or analyzed for assay results.

The dispensing system 30 provides numerous advantages based upon the ability of the reagent jetting head 400 to rapidly and reproduceably eject uniform quantities of a wide range of reagents. The reaction times of some chemical processes are dependent upon the volume of the reagents used. The ability of the dispensing system 30 to dispense such minute amounts of reagents thereby reduces the processing time

of certain chemical assays. Furthermore, some chemical assays require a wide range of dilution ratios. Many conventional dispensing systems are unable to dispense the reagents in volume small enough to make the desired assay practical. The dispensing system of the present invention overcomes this disadvantage.

In addition to dispensing reagent fluids, certain embodiments may be used for precision printing of reagents onto a printing medium such as filter paper to produce an assay test strip. A printing system 10 using the present invention is represented in Fig. 3. Structure similar in form and function to structure described above will be designated by like reference numerals. The printing system 10 comprises a reagent fluid reservoir 200, a filter 300, a reagent jetting head 400, a jetting head control unit 500, an interface 600, a computer 700, and an x-y plotter 800.

The x-y plotter 800 is a commercially available pen plotter, mechanically modified in a conventional manner such that the pen is replaced with the jetting head 400. The general operation and structure of the plotter 800 will not be described in detail. The plotter 800 accepts commands from the computer 700 thru a standard RS-232 serial interface contained within the interface unit 600. The plotter 800 processes the commands and produces control signals to drive an x-axis motor (not shown) and a y-axis motor (not shown). The x-axis motor is used to position the jetting head 400 and the y-axis motor is used to position a drum (not shown) to which the printing target 1 is attached.

The plotter 800 produces a pen down signal PENDN. This signal is applied to the control unit 500 and indicates that the plotter 800 is ready to begin a printing operation.

The control unit 500 also receives control signals from the interface unit 600. These signals include signals HIGHER*, LOWER* to control the magnitude of the pulse applied to the transducer 434; a reset signal RST to reset the control unit 500; and a series of print signals PRT*. The generation of these signals will not be described in detail since their production is performed by the conventional interface unit 600.

The jetting head 400 and fluid supply system 200, 300 are initialized and operate substantially as described above. The jetting head control unit 500, shown in Figs. 5a - 5e comprises a print control circuit 510, a pulse generator 530, a high voltage supply 540, and a strobe pulse generator 560. The control unit 500 also comprises a power supply. However, since the power supply is of conventional design it will not be shown or described in detail.

The print control circuit 510 receives the pen down signal PENDN from the plotter 800 and comprises a transistor Q100, a one-shot circuit U100, two NAND-gates U101, U102, a line decoder multiplexer U107 and four inverters U103-U106. The pen down signal PENDN is applied to the base of the transistor Q100 by resistors R100, R101 and diode D100. The emitter of transistor Q100 is tied to ground and the collector is connected to the +5 volt supply by resistor R102.

The one-shot U100 comprises inputs A, B and an output Q. The B input of the one-shot U100 is connected to the collector of the transistor Q100 and the A input is tied to ground. The time period of the pulse produced by the one-shot U100 is determined by a resistor R104, a variable resistor R105 and a capacitor C100. The output Q of the one-shot U100 is combined with the collector output of the transistor Q100 by the NAND-gate U101 and then inverted by the NAND-gate U102. The circuit is operative to produce an adjustable delay in the application of the pen down signal PENDN to the control unit 500.

The line decoder U107 is circuited to function as a 3 input AND-gate. The output of the NAND-gate U102 is applied to the first input of the decoder U107; the print signal line PRT* comprising a series of pulses from the interface unit 600 is applied to the second input; and a jetting head ON/OFF signal from switch S1 is applied to the third input. The inverter U106 inverts the output of the line decoder U107 to generate the print control signal PRT* and the inverters U103-U105 invert the control signals LOWER*, HIGHER*, and RST signals, respectively.

The high voltage supply 540, shown in Fig. 5b, provides +175 volts DC to produce a maximum pulse of +150 volts peak to peak at the reagent jetting head 400. The high voltage supply 540 comprises differential amplifier U12 and transistors Q1, Q2, Q13, Q14. A stable reference voltage of -2.5 volts DC is produced at the junction of a reservoir R13, connected to the -15 volt supply, and a diode CR6, connected to ground. The reference voltage is combined with a resistor R14 to produce an adjustable, stable voltage reference for the amplifier U12. The reference voltage is applied to the inverting input of the amplifier U12 through a resistor R11. The noninverting input of the amplifier U12 is connected to ground by a resistor R12. The amplifier U12, in combination with a feedback resistor R10, produces an output signal proportional to the difference of the voltage reference signal and the ground potential.

The output of the amplifier U12 is applied to the base of the transistor Q2 whose collector is connected to the +15 volt supply. The signal produced at the emitter of the transistor Q2 is applied to the base of the transistor Q1 through resistors R8, R6, R5, a transformer L1 and diodes CR4, CR2, CR1. The emitter of the transistor Q1 is connected to ground and the collector is connected to the +15 voltage supply through the

transformer L1. A diode CR3 connects the collector of the transistor Q1 to the junction of the resistor R5 and the diode CR4. The transistor Q1 is biased for proper operation by resistors R7, R6, R5. The resistor R7 and a capacitor C22 connect the junction of the resistor R8, R6 to the +15 voltage supply.

The transistor Q1 and the transformer L1 form a "flyback" blocking oscillator. Any increase in current supplied by the transistor Q1 produces an increase in energy transferred through the secondary winding of the transformer L1 and diode CR5. Therefore, an increase in current supplied by the transistor Q1 results in an increase in power available to the high voltage output. The diodes CR1-CR4 form a "Baker clamp" which prevents transistor Q1 from saturating. The clamp thereby avoids transistor storage time.

The diode CR5 is connected to a multiple pi filter formed by the inductors L3, L2, capacitors C24, C21, C41 and resistors R29. The multiple pi filter attenuates ripple and switching spikes in the signal supplied to the transistor Q13 which produces the high voltage output V+ +. A resistor R64 connects the base of the transistor Q13 to the emitter and to the resistor U29. The base is also connected to the collector of the transistor Q14 by a resistor R65. The base of the transistor Q14 is connected to the +15 volt supply by a resistor R67 and to ground by a resistor R66. The emitter of the transistor Q13 provides a signal HV SENSE which is fed back to the inverting input of the amplifier U12 through a resistor R9. The high voltage output V+ + is produced at the collector of the transistor Q13. The proper biasing of the transistor Q13 is provided by resistor R64 and the biasing circuit comprising the transistor Q14, resistors R67, R66, R65.

The pulse generator 530, shown in Figs. 5d, 5e, comprises an opto-isolator U18, a one-shot U23, a digital to analog (D/A) converter U30 and two binary counters U24, U25. The pulse generator 530 accepts control signals PRT", LOWER", HIGHER", RST and produces the activation pulse which is applied to the transducer 434. In normal operation, the PRT" control signal is supplied to the opto-isolator U18 by a jumper JMP between contact points E5, E6. The opto-isolator U18 is of conventional design and comprises a light emitting diode (LED) circuit and a photo-element circuit. A resistor R15 operates as the load resistor for the LED circuit of the isolator and a capacitor C25 suppresses transient noise on the voltage supply to the isolator U18. The output of the isolator U18 is applied to one input of the one-shot U23 whose time constant is adjustably determined by resistors R38, R25 and a capacitor C30. The pulse from the non-inverting output of the one-shot U23 is fed to the base of a transistor Q9. A resistor R39 sets the approximate base current of the transistor Q9 which is used as a level shifter for converting the CMOS signal level to the +15 volt DC signal level.

The control of the rise and fall rates of the pulse generator 530 is accomplished by directing a pair of current source transistors Q11, Q12 to charge and discharge a capacitor C57. The transistor Q11 is operative as a source of current and the transistor Q12 is operative as a sink for current. A transistor Q10 controls the level of the current by applying an appropriate bias current through a resistor R56 to the base of the transistor Q11. The biasing of the transistors Q11, Q12 is critical to the proper rise and fall rates. Therefore precision voltage references CR13, CR15 are used to provide respective bias reference voltages. A temperature compensation network is formed from zener diodes CR14, CR16 and resistors R55, R54 to maintain stable operation of the transistors Q11, Q12, respectively. The variable resistors R49, R52 may be used to adjust the fall time and rise time, respectively, of the output pulse applied to the reagent jetting head 400. A plurality of resistors R45, R46, R47, R48, R49, R51, R52, R53, R56, R57, R58 are used to properly bias the transistor Q10, Q11, Q12 and capacitors C55, C60 are circuited to maintain stability of the circuit.

The impedance of the output stage of the rise and fall circuitry Q10, Q11, Q12 is very high. With such a high impedance, circuit elements attached to the capacitor C57 could affect the linearity of the rise and fall time constants. Therefore, an FET input operational amplifier U32 is used as an impedance interface. The amplifier U32 is configured in the noninverting mode and circuited with capacitors C58, C59 for stability.

The output of the amplifier U32 is applied to an inverting amplifier U31 by means of a resistor R62. The amplifier U31 inverts and conditions the pulse control signal with the aid of resistors R59, R60. Resistors R61, R63, connected to the -15 voltage supply, provide a means for adjusting the DC level offset of the amplifier U31 output signal. Capacitors C51, C52 are connected to enhance the performance and stability of the circuit.

The output of the amplifier U31 is applied by means of a resistor R41 to the positive voltage reference signal input REF(+) of the D/A converter U30. The negative voltage reference signal input REF(-) is tied to ground by a resistor R40. The D/A converter U30 produces output signals IOUT, IOUT" which are proportional to the difference between the positive and nega tive voltage reference signal inputs REF(+), REF(-). Capacitors C48, C49, C50 are connected to the D A converter U30 to enhance stability.

The D/A converter outputs IOUT, IOUT" are also proportional to an 8-bit binary value applied to inputs B1-B8. The binary value is supplied by the counters U24, U25 which are controlled by the function signals LOWER", HIGHER" and RST. The LOWER" signal and the HIGHER" signals are applied to the count up and

delay, the signal is ANDed with the closed enable switch S1 and the series of print pulses PRT'. The result of the AND operation is the application of the PRT' pulses to the pulse generator circuit 530.

The PRT' signal is applied through the jumper JMP to the opto-isolator U18 and then to the one-shot U23. The one-shot U23 produces a pulse signal which is then converted from CMOS signal levels to the 15 volt DC signal level by the transistor Q9. The rise and fall circuitry comprising Q10, Q11, Q12 converts the square wave pulse into a pulse having the rise and fall characteristics preset by the resistors R49, R52. The conditioned pulse is then amplified by the amplifier U32 and applied to the amplifier U31.

The amplifier U31 converts the polarity of the conditioned pulse to that acceptable by the D/A converter U30 and supplies an adjustable DC offset. The DC offset is used to counteract possible distortion attributable to the amplifier U31. The distortion arises in that, for the amplifier U31 to be adequately responsive, a small degree of current must flow through the resistor R41. This current creates an offset condition at the output of the amplifier U29 which is then scaled by the D/A converter U30 in correspondence with the binary data. The resistor R63 allows a small amount of current to be applied to the amplifier U31 to control the offset voltage attributable to the current flowing through the resistor R41.

The D/A converter U30 scales the difference between the inputs REF(+), REF(-) using the binary data supplied to input lines B1-B8 to produce a current output pulse IOUT and a current inverted output pulse IOUT'. The two outputs IOUT, IOUT' are fed to the amplifier U29 which convert the current outputs into a single voltage output. The scaled, conditioned pulse is then applied to the output circuit comprising the amplifier U28 and the transistors Q3, Q4, Q5, Q6, Q7. The circuit produces a high voltage pulse with the aforementioned rise and fall characteristics to drive the piezo-electric transducer 434.

The high voltage pulse is applied to the transducer 434 and causes a droplet 2 of fluid to be propelled onto the target 1. Since the pen down signal PENDN is still applied, additional droplets 2 are produced from the jetting head 400. The plotter 800 moves the jetting head 400 and target 1 along the desired path during the emission of the droplets 2 to produce the desired printed line. When the printing is complete, the plotter 800 removes the pen down signal PENDN and the droplet emission stops. Of course it should be understood that dots, circles and the like could be produced by appropriate positioning of the target 1 and jetting head 400.

The size and uniformity of the droplets 2, as well as the presence of any satelite droplets, may be observed with the aid of the scope 950 and the LED 900. The scope 950 and the LED 900 are positioned such that the droplets 2 pass between the scope 950 and the LED 900 and within the focal range of the scope 950. The strobe pulse when applied to the LED 900 causes the LED 900 to momentarily flash. The timing of the activation and the width of the pulse may be adjusted such that the flash occurs when the fluid, expelled in response to the high voltage pulse, is between the scope 950 and the LED 900. The dispensed quantity of fluid may then be observed in flight or at or near the momement of separation from the orifice 433. Corrections based on the observation may then be made to the system 10.

Since each droplet 2 is small in volume, the droplet 2 may be rapidly absorbed by the target 1, thereby allowing rapid and precise placement of a variety of reagents on the target 1 with reduced drying time and reduced potential of fluidity mixing. In addition, the ability to place small droplets 2 in a precise manner enables the target 1 to be printed in a high density matrix with a variety of reagents as isolated matrix elements.

In some printing applications, particularly when printing fluids of low viscosity and surface tension, it may be desirable to force the fluid through the jetting tube 432 under pressure and allow the vibrations produced by the transducer 434 to break the emitted fluid stream into precise droplets 2. Under this mode of printing, the emission of droplets 2 can not be stopped by cessation of the tranducers activation pulse. It is therefore necessary to prevent fluid emission by other means. One preferred means of momentarily stopping emission of the droplets is shown schematically in Fig. 4. In this arrangement, structure similar to structure represented in Fig. 3 in form and function, is represented by like reference numerals.

The arrangement, generally represented by the numeral 20, includes a closed reagent recirculation system comprising a normally close three way valve 970, a sump 960 and a recirculation pump 980. In the continuous mode, the reagent fluid is forced out the orifice 433 by hydraulic pressure and broken into a series of substantially uniform droplets 2 by movement of the transducer 434. A regulated, filtered air supply 100 is used to pressurize the reagent fluid reservoir 200. The reagent fluid within the reservoir 200 may optionally be agitated by a magnetic stirer unit 990. This is especially useful for reagent fluids comprising suspended particles.

The three-way valve 970 comprises a common channel, a normally open channel and a normally closed channel. The fluid is forced through the filter 300 and applied to the normally closed channel of the valve 970. When the normally closed channel is closed, the normally open channel of the valve 970 functions as a vent for the reagent jetting head 400. The common channel is connected to the reagent supply tube 430

of the jetting head 400. The reagent supply tube 430 is also connected to the sump 960.

In operation, the normally closed channel is opened by an appropriate signal supplied by the computer 700 which also closes the normally open channel. When the normally closed channel is opened, fluid is permitted to pass to the sump 960 and to the jetting head 400. The sump 960 collects the reagent fluid not transferred to the jetting head 400. The sump 960 supplies the collected fluid to the inlet side of the recirculating pump 980 which returns the fluid to the reservoir 200. The returned fluid is then mixed with the contents of the reservoir 200 and is available for recirculation.

When operating in the continuous mode, rather than interrupt the continuous stream of print pulses to the jetting head 400, the printing may be momentarily stopped by closing the normally closed channel of the valve 970. The closing of the normally closed channel stops the flow of reagent fluid to the jetting head 400 and allows the jetting head 400 to vent to atmospheric pressure. With the fluid supply blocked, the transducer 434 is unable to expel further droplets 2. Thus, if positioning of the target 1 by the plotter 800 requires a longer time interval than the time between droplet 2 emission, the computer 700 may close the normally closed channel of the valve 970. The plotter 800 may then position the target 1 or position a new target 1 as desired.

When printing, the active ingredient of the reagent is tailored to achieve a desired concentration per unit area on the target 1. However, to a certain extent the final concentration per unit area can be adjusted by varying the density of the droplets 2 printed on the target 1. The preferred embodiment is particularly well suited to this application due to its ability to print precise, discrete pels of reagent.

A second preferred embodiment of the jetting head is illustrated in Figs. 6a-6b and is generally represented as 400'. The jetting head 400' comprises a housing formed into three sections 401', 402', 403'. The housing section 403' comprises a recessed region which forms the reagent fluid reservoir 200' when the housing section 403' is positioned against housing section 402'.

The jetting head 400' further comprises a piezo-electric transducer 434' and a reagent jetting tube 432' similar to those of the first embodiment. The jetting head 400' and the transducer 434' are most clearly shown in Fig. 6b. The jetting tube 432' defines an orifice 433' at one end and a reagent fluid receiving aperture 431' at the other end. The transducer 434' is mounted to the jetting tube 432' concentrically about the mid-region of the tube 432' with epoxy.

The transducer 434' and the jetting tube 432' are positioned in channels 420', 418', 416' located in the housing sections 402', 401'. The channel 416' comprises a plurality of sealing teeth 412' operative to engage and seal against the fluid receiving end 431' of the jetting tube 432'. The channel 416' is connected to the reagent fluid supply channel 430'. The supply channel 430' is connected with the fluid reservoir 200' by means of an aperture 431' through the housing section 402', shown in Fig. 6b.

The reservoir 200' comprises a flexible reservoir lining 201' adapted to contain the reagent fluid. The lining 201' comprises one aperture which is connected to the housing 402' to allow the fluid to pass from the lining 201'. A vent (not shown), located in the housing 403', allows the space between the reservoir 200' and the lining 201' to be vented or pressurized. A filter 300' is positioned within the aperture 202' to trap unwanted particulate foreign matter.

Electrical pulses are supplied to the transducer 434' by means of two contact pins 422'. The pins 422' are inserted through respective apertures 419' of the housing section 402' and respective apertures 421' of the housing section 403'. Two thin electrically conductive strips 410', 411', shown in Fig. 6b, are used to connect the transducer 434' with the contact pins 422'. A protective shield 405' extends from the housing position 403' to partially isolate the protruding portions of the contact pins 422'.

The function and operation of the jetting head 400' is similar to that of the jetting head 400 and therefore will not be discussed in detail. The collapsible inner lining 201' of the reservoir 200 allows the jetting tube 432' to be primed by pressurizing the reservoir 200' through the vent 205'. Once primed, the jetting head 400' may be used as described above in reference to the jetting head 400.

The jetting head 400' provides an advantage in that the entire fluidic system is contained in one housing. Such containment allows for fast and efficient replacement of the jetting heads without fluid contamination problems.

A third preferred embodiment of the jetting head is shown in Fig. 7 and generally represented as 400". The jetting head 400" comprises a housing 403", a reagent fluid supply tube 406", a piezo-electric transducer 434" and an orifice plate 404". The housing 403" defines a conically shaped fluid chamber 432". An orifice plate 404", defining an orifice 433", is fastened to the housing 403" such that the orifice 433" is located at or near the apex of the conical fluid chamber 432".

The fluid feed tube 406" is attached to the housing 403" and defines a supply channel 430". The supply channel 430" is in fluid communication with the fluid chamber 432" by means of a connecting channel 431". The base of the fluid chamber 432" is formed by the disc-shaped transducer 434". The transducer 434" is

held in position by a hold down plate 402" attached to the housing 403". The electrical connec tions to the transducer 434" are of conventional design and are therefore not shown. The housing 403" further comprises a threaded aperture 406" for mounting the jetting head 400".

The jetting head 400" operates in a manner similar to the jetting heads described above. However, in this jetting head the transducer 434" is normally disk shaped. When the electrical pulse is applied, the transducer 434" bends slightly, thereby altering the volume of the conically shaped jetting chamber 432". The change in volume of the chamber 432" causes the expulsion of fluid through the orifice 433" and the intake of fluid through the supply-channel 430" as described in reference to the jetting head 400.

A fourth preferred embodiment of the jetting head is shown in Fig. 8 and is generally represented as 400" . The jetting head 400" is very similar in form and function to the jetting head 400 and will not be described in detail. The jetting head 400" comprises two symmetrical housing sections. The sections may be connected together by means of apertures 409" and screws, not shown. When assembled, the housing sections 404", 402" form a T-shaped supply channel 410" .

In operation, the jetting head 400" functions in a manner similar to the jetting head 400. The jetting head 400" is especially suited for use in the continuous mode, but may also be used in the drop on demand mode. In the continuous mode, the fluid is circulated continuously through the supply channel 430" allowing the jetting tube 432" to withdraw as much fluid as required.

By way of illustrating and with no limitations intended the following information is given to further illustrate the above described embodiments. The computer 700 is an IBM Corporation Personal Computer with 640 kbytes of RAM memory. The interface unit 600 is a Burr Brown interface unit model number PC 20001. The plotter 800 is manufactured by Houston Instrument as model number DMP-40. Communication between the plotter 800 and the interface unit 600 is performed through a standard asynchronous serial communication port.

The electrical pulse applied to the jetting head 400 to activate the transducer 434 comprises a rise time of approximately 5 usecs, a fall time of approximately 5 usecs and a pulse width of approximately 35 usecs. When the transducer 434 is operated in the drop on demand mode, the voltage potential of the pulse is 60 volts plus or minus 10 volts and the pulse frequency can be up to 4 khz. When the transducer 434 is operated in the continuous mode, the voltage potential of the pulse is 30 volts plus or minus 10 volts and the pulse frequency can be up to 10 khz.

The jetting tube 432 is manufactured from a pyrex glass tube and measures .027 inches outside diameter and .020 inches inside diameter. The tube is drawn to a closed taper in an electric furnace. The tapered end is then cut and ground to a desired orifice opening of .002 to .004 inches in diameter. The tube is cut to a final length of .945 inches in the case of the dispenser embodiment and ultrasonically cleaned in acetone. After being cleaned and dried the large end of the tube is fire polished. If desired, the orifice end of the tube may receive a coating, such as a hydrophobic polymer, to enhance droplet separation from the tube.

The supply tube 430 is formed from .023 inch inside diameter and .38 inch outside diameter polyethylene tubing produced by Intramedic Corp. as model number #14 170 11B. During assembly, one end of the tubing is stretched over a warm tapered mandrel. The stretched end of the supply tube 430 is then inserted over the large fire polished end of the jetting tube 432. The assembly is then cleaned and baked in a circulating air oven at 50°C. for 10 minutes.

The transducer 434 was purchased from Vernitron of Cleveland, Ohio as model number PZT-5H. The electrodes 437, 438 are comprised of nickel and are separated from each other on the outer surface of the transducer by approximately .030 inches. The jetting tube 432 is inserted into the cylindrical piezo-electric tube 434 and secured with epoxy manufactured by Epoxy Technology of Bellenca, Massachusetts as model number 301. The epoxy is applied at the junction of the tube 432 and transducer 434 with a syringe. The epoxy flows along the tube 432 inside the transducer 434 by capillary action. The assembly is then baked in a circulating air oven at 65°C. for one hour to cure the epoxy.

The contact pins 422 are secured to one of the housing sections 402, 404 with a drop of epoxy. The transducer jetting tube 434, 432 is placed in the housing such that the orifice end 433 of the tube 432 protrudes approximately .030 inches from the housing 403, 404. A drop of silver epoxy is placed between each contact pin 422 and the transducer 434 to ensure a secure electrical connection. Epoxy is also applied to the junction of the housing 402, 404 and supply tube 430. The other section of the housing 402, 404 is then screwed into place.

The periphery of the housing 402, 404 is sealed with a capillary sealer such as cyclohexanone. Epoxy is then added around each contact pin 422 and around the orifice end 433. The assembly is then baked in a circulating air oven at 65°C. for one hour.

The filter 300 is formed from a polyester mesh with 30 um pores and positioned in a polypropylene

housing. The air pressure supplied to the reservoir 200 during continuous printing operations is regulated at approximately 10 to 30 psi.

The reagents used have the following characteristics:

Printing (drop on demand mode):
Fluid viscosity range: 1 - 30 centipoises
Fluid surface tension: 20 - 70 dyne/cm
Printing (continuous mode):
Fluid viscosity range: up to 50 centipoises
Fluid surface tension: not measured
Dispensing (drop on demand mode):
Fluid viscosity range: 2 - 30 centipoises
Fluid surface tension: 20 - 70 dyne/cm

A measure of the performance and selected operating characteristics for a typical jetting head are presented in Figs. 9-11. Fig. 9 is a graph of the mass of a droplet as a function of droplet emission frequency for three fluids. The viscosity of the fluids were 1, 5 and 24 centipoise and the transducer excitation pulse width was 35 microseconds. As shown in Fig. 9, the higher fluid viscosity results in a more stable operating performance of the jetting head. Fig. 10 is a graph of droplet velocity as a function of droplet emission frequency for fluid viscosities of 1, 5 and 24 centipoise. The log of the total fluid weight as a function of the log of the number of droplets emitted is shown in Fig. 11. The fluid used has a viscosity of 2 centipoise, a surface tension of 20 dynes/cm, and a density of .8 grams/cc. The transducer excitation pulse was 80 volts and the excitation frequency was approximately 711 Hz.

Some blood typing reagents and some allergen reagents have very low viscosities and surface tensions. Although in some cases viscosity modifiers, such as glycerol, dextran, glucose, and the like, may be added to increase the viscosity, a few reagents are adversely affected by such modifiers.

Developing stable and reproduceable demand mode jetting is difficult with very low viscosities. Although droplet emission can be established at some fundamental frequencies, the droplets dispensed may have small satelite droplets which reduce the accuracy for metering and dispensing applications. However, even with the satelite drops, sufficient reagent is adequately delivered for most print applications without a substantial decrease in print quality.

Glycerin may be used as a viscosity modifier to improve jetting reliability and to prevent obstruction of the orifice arising from evaporation of the reagent fluid components. Glycerin has been found especially beneficial for those reagents containing particulate material. The evaporation of the fluid component results in a concentration of glycerin located at the orifice. The plug of glycerin substantially prevents further evaporation of the reagent fluid. During the next activation cycle of the transducer, the plug of glycerin is expelled from the orifice.

When operating in the dispensing mode the volume of the droplets can be varied to substantially uniformly contain from 100 pico-liters to 1 micro-liter. The droplets can be produced at a rate of approximately 1 khz to 8 khz. When operating in the printing mode the size of the pel made by each droplet measures approximately .001-.012 inches in diameter.

A copy of the program used in the computer 700 for a printing operation is attached hereto as Appendix A. The values, manufacturer and manufacturing part number of the circuit components of the jetting control unit 500 are substantially as follows:

Ref. Numeral of Component	Description and Value	Manufacturer and Part No.
R39,45-48,57, 58	RES.10KOHM½WATTS%C.F.	
R66	RES.1500HM½WATTS%C.F.	
R3	RES.15KOHM½WATTS%C.F.	
R34	RES.16KOHM½WATTS%C.F.	
R50	RES.2.4KOHM½WATT1%M.F.	DALE RL0792-2C
R13,23,36,40, 41	RES.2.4KOHM½WATTS%C.F.	
R56	RES.20KOHM½WATTS%C.F.	
R8	RES.220OHM½WATTS%C.F.	
R6	RES.270HM1WATTS%C.C.	
R7,12,25	RES.2KOHM½WATTS%C.F.	
R67	RES3.6KOHM½WATTS%C.F.	
R51,53	RES.3.9KOHM½WATTS%C.F.	
R29	RES.300KOHM½WATTS%C.F.	
R61	RES.30KOHM½WATT1%M.F.	DALE RL0793-03C
R15-18,26-28, 54,55,64	RES.4.7KOHM½WATTS%C.F.	
R62	RES.45.3KOHM½WATT1%M.F.	DALE RN55D4532F
R30,33	RES.470HM½WATTS%C.F.	
R21	RES.4700HM½WATTS%C.F.	
R19	RES.47KOHM½WATTS%C.F.	
R35	RES.5100HM½WATTS%C.F.	
R43	RES.5.2KOHM½WATTS%C.F.	
R60	RES.7.5KOHM½WATTS%C.F.	
R37	RES.75KOHM½WATTS%C.F.	
R9	RES.76KOHM½WATT1%M.F.	DALE RN60D7682F
R11	RES.8200HM½WATTS%C.F.	
U2,11,14,16,22	RES.DIP NETWRK.47KOHM	CT9 761-1R47K
C21,41,45	CAP.AXIAL1MF@250VDC	MALLORY #TCS6
C24	CAP.AXIAL220MF@250VDC	MALLORY LF22192S0C7P3
C10	CAP.AXIAL ALUM ELEC. 4700 OMF@25VDC	MALLORY TCG472UC2SNIC
C1,2,3,55,60	CAP.RADIAL DIPPED TANT. 10MF@25VDC	KEMET T350E106M025AS
C53	CAP.RADIAL DIPPED TANT. 1MF@35VDC	KEMET T350A105K035AS
C36	CAP.RADIAL DIPPED TANT. 47MF@10VDC	KEMET T350E566MC10AS

Ref. Numeral of Component	Description and Value	Manufacturer and Part No.
C54	CAP.RADIAL SILV MICA 100PF300VDC	KAHGAN SD5101J301
C57	CAP.RADIAL SILV MICA 20PF300VDC	KAHGAN SP12200J301
C49	CAP. RADIAL SILV. MICA 39PF300VDC	KAHGAN SP12390J301
C39	CAP.RADIAL X7R MLC .015MF@50VDC	KEMET C315C102K1R5CA
C6	CAP.RADIAL X7R MLC .022MF@50VDC	KEMET C315C223K5R5CA
C30,35,37	CAP.RADIAL Z5U MLC .015MF@50VDC	KEMET C315C153K5R5CA
C4,7	CAP.RADIAL 25U MLC .01MF@50VDC	KEMET C315C103K5R5CA
C4,5,6,9,11-19, 22,23,25-28 C31-34,37,42,43 47,48,50-52 C56,58,59	CAP.RADIAL 25U MLC .22MF@50VDC	KEMET C322C224M5U5CA
C46	CAP.VARI.2-12PF.	JOHANSEN #9626
CR7,8,9,10, 11,12,17	DIODE SIL.	ITT.FAIRCHLD.1N4148
CR1,2,3,4	DIODE SIL.FAST	GENL.INST.EGP10D
CR5	DIODE SIL.FASTHIVOLT	GENL.INST.UF4007
CR6,13,15	DIODE SIL.REF.2,500VDC	NATL.SEMI-LM3852-2.5
CR14,16	DIODE SIL.ZENER3.3V.25WATT	MOTOROLA 1N4622A
U6,13,15,17	SWITCH 8 POSITION DIP	CTS 206-8
Q2,9,12	TRANSTOR.COMMON NPN	MOTOROLA 2N2222A
Q8,10,11	TRANSTOR.COMMON PNP	MOTOROLA 2N2907A
Q4	TRANSTOR.HIVOLTHIFREQ.NPN	MOTOROLA MPSU10
Q7	TRANSTOR.HIVOLTHIFREQ.PNP	MOTOROLA MPSU60
Q1	TRANSTOR.HIVOLTHI.NPN	TI,MOTOROLATIP48
Q3,14	TRANSTOR.HIVOLTNPN2N3439	MOTOROLA 2N3439
Q13	TRANSTOR.HIVOLTPNP	MOTOROLA MJE5731
U5,27	IC 1-SHOT 74HC221	NATL.SEMI MM74HC221N
U23,26	IC 1-SHOT 74LS221	NATL.SEMI DM74LS221N
U7-10	IC COMPARATOR 74HC688	NATL.SEMI MM74HC688N
U30	IC CONVERTER DAC0800	NATL.SEMI DAC0800LCN
U24,25	IC COUNTER 74HC193	NATL.SEMI MM74HC193N
U28	IC HI SLEW HI VOLT OP AMP	BURR-BROWN 3584JM
U1	IC HYBRID DC/DC CONVERTER	BURR-BROWN MODEL 724
U4	IC OC DRIVER SN7406	NATL.SEMI DM7406N
U3	IC OCTAL LATCH 74HC374	NATL. MM74HC374N
U12,29,31,32	IC OP AMP LF256	NATL.SEMI LF256H
U18,19,20,21	IC OPTO ISOLATOR	HEWLTT-PCKRD HCPL2300
R24,42,63	POT100KOHM½WATT10%	BOURNS 3622-1-104
R38,49,52	POT10KOHM½WATT10%	BOURNS 3622W-1-103
R20	POT25KOHM½WATT10%	BOURNS 3622W-1-253
R14,31	POT2KOHM½WATT10%	BOURNS 3622W-1-202

Ref. Numeral of Component	Description and Value	Manufacturer and Part No.
VR1	REGULATOR 5VDC	NATL.LM340T-5.0
R10	RES.1MEGOHM½WATTS%C.F.	
R2,4	RES.1.2KOHM½WATTS%C.F.	
R32	RES.1.6KOHM½WATTS%C.F.	
R44	RES.1.8KOHM½WATTS%C.F.	
R1	RES.10MEGOHM½WATTS%C.F.	
R5,R22	RES.100OHM½WATTS%C.F.	
R65	RES.100KOHM½WATTS%C.F.	
R59	RES.10KOHM½WATT1%M.F.	DALE RN55D1002F
R100	RES.270OHM	
R101,108	RES.470OHM	
R102,103 106,109,110	RES.1KOHM	
R104	RES.47000HM	
R105	POT.100KOHM	
R107	POT.10KOHM	
R111,113	RES.2200HM	
R112	RES.220HM	
R114,115	RES. 470HM	
C100	CAP.10MF035 VFC	
C108	CAP.10000 PF	
D100	DIODE	1N4148
Q100,105	TRANSTOR	2N2222
Q101,102	TRANSTOR	2N3906
Q103,104	TRANSTOR	2N3904
U100,U108	IC 1-SHOT	74LS123
U103,104 105,106	IC INVERTOR	74LS04
U108	IC LINE DECODER	74LS138

Of course, it should be understood that a wide range of changes and modifications can be made to the preferred embodiments described above. For example, the transducer could be of a type other than piezo-electric such as magneto-strictive, electro-strictive, and electro-mechanical. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, which are intended to define the scope of this invention.

APPENDIX

```
5
   Reagent Jet Printer
   Reagent Calibration                                                    PAGE  1
                                                                          07-14-84
                                                                          12:24:57
   Offset  Data    Source Line                    IBM Personal Computer BASIC Compiler V2.00

10 0030    0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Reagent Calibration' $LINESIZE: 132
   0030    0006    '$INCLUDE: 'REAGCAL'
   0030    0006    '
   0030    0006    'AUTHOR   - B. A. Emerald
   0030    0006    '
   0030    0006    'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
15 0030    0006    'REVISION - 2.0 07-01-84 BAE Microfab modifications
   0030    0006    '         - 1.0 02-11-84 BAE Creation of initial code
   0030    0006    '
   0030    0006    'SYSTEM   - This code can only be compiled by the BASCOM
   0030    0006    '           COMPILER, it will not run under the INTERPRETER!!
   0030    0006    '
20 0030    0006    'DESCRIPTION:
   0030    0006    '       The reagent calibrate module presents a menu with 12 items arranged
   0030    0006    '       in 3 columns of 4 rows.  The arrow keys allow movement around the
   0030    0006    '       table, the + and - keys increment or decrement values in the first
   0030    0006    '       column, and the enter key executes commands in the third column.
   0030    0006    '       The second column is an array of ASCII strings representing reagent name,
25 0030    0006    '       concentration, density, and viscosity.  The values entered in column one
   0030    0006    '       are drop frequency, pulse width, strobe delay, and nozzle number.
   0030    0006    '       The commands in the third column are start/stop, load, save, and exit.
   0030    0006    '
   0030    0006    'DATA DICTIONARY
   0030    0006    '       MENUX           Pointer to which menu item is active (0-11)
30 0030    0006    '       MENUS(17,1)     Array for strings used to display the menu
   0030    0006    '       MENU(17,4)      Array for numbers in the menu display
   0030    0006    '       BUFF%           Differential to move MENUX at arrow key input
   0030    0006    '       TYPE%           Pointer set during main scan to direct action
   0030    0006    '       KEYBUF$         Storage for string input from menu display
   0030    0006    '       A$              Destination for single keystroke inputs
35 0030    0006    '       FILE$           String where filename is built for reagent data file
   0030    0006    '       SEARANGE$       String where reagent name is stored
   0030    0006    '       CE              Row to display special graphics character in menu
   0030    0006    '       CE              Column to display special graphics character in menu
   0030    0034    '       CE              Special graphics character is read into here
   0030    0006    '       DLJ.AMP.VALUE%  Integer value for setting pulse amplitude
40 0030    0006    '       DIR.VAL%        Value set to digital port 0 to inc/dec amplitude
   0030    0006    '
   0030    0006    SUB REAGENT.CALIBRATE STATIC
   0047    0006
   0047    0006            DIM MENUS(17,1),MENU(17,4)
   0048    01FE
45 0048    01FE            GOSUB INITIALIZE:       'read init. values and set screen
   004E    01FE
   004E    01FE            WHILE TYPE% <> 1
   0051    0200
   0051    0200              TYPE% = 0
   0060    0200              A$ = ""
50 0064    0204
   0064    0204              WHILE A$ = ""
   0079    0204                A$ = INKEY$
   007E    0204                IF ACTIVE% = 1 AND DOWNTIME < TIMER THEN GOSUB PIX.DOWN
   0088    0208              WEND
   0090    0208
55
```

```
Reagent Jet Printer                                                                    PAGE  2
Reagent Calibration                                                                    07-14-86
                                                                                       12:26:37
Offset  Data    Source Line                                    IBM Personal Computer BASIC Compiler V2.00

0080    020A            IF A$ = CHR$(13) THEN TYPE% = 1:          'execute (cr)
00CA    020A            IF A$ = "+" THEN TYPE% = 2:               'increment variable
00E0    020A            IF A$ = "-" THEN TYPE% = 3:               'decrement variable
00F6    020A            IF A$ = CHR$(0) + CHR$(72) THEN TYPE% = 4:  'up arrow key
011D    020A            IF A$ = CHR$(0) + CHR$(80) THEN TYPE% = 5:  'down arrow key
0140    020A            IF A$ = CHR$(0) + CHR$(75) THEN TYPE% = 6:  'left arrow key
0163    020A            IF A$ = CHR$(0) + CHR$(77) THEN TYPE% = 7:  'right arrow key
018A    020A            IF A$ > CHR$(47) AND A$ < CHR$(123) THEN TYPE% = 8:' ascii 0 - z
01C2    020A
01C2    020A            ON TYPE% GOSUB T1, T2, T3, T4, T5, T6, T7, T8
01D8    020A
01D8    020A          WEND
01DF    020A          TYPE% = 0
01E6    020A
01E6    020A          EXIT SUB
01EA    020A    REM $PAGE
```

```
Reagent Jet Printer                                                                    PAGE  3
Reagent Calibration                                                                    07-14-86
                                                                                       12:23:37
 Offset  Data   Source Line                                  IBM Personal Computer BASIC Compiler V2.00

 01EA   0203   '********** SUBROUTINES FOR THIS MODULE **********
 01EA   0206
 01EA   0206   T1:          '(cr) execute command
 01EF   0206           IF PEEK(X < 12 THEN TYPE% = 0:RETURN:    'exit to print menu, no action
 0205   020C           ON KEY% - 11 GOSUB T1A, T1B, T1C, T1D
 021A   020C           IF KEY% < 15 THEN TYPE% = 0
 0225   020C           RETURN
 0226   020C
 0230   020C   T1A:          'start/stop drop flow
 0233   020C           IF KEY$(12,0) = "START" THEN GOSUB START.INK
 0256   020C           IF KEY$(12,0) = "STOP " THEN GOSUB STOP.INK
 027F   020C           KEY$(12,0) = TEMP$
 0296   0210           COLOR 0,7:GOSUB DISPMENU
 02AC   0210           RETURN
 02B0   0210
 02B0   0210   START.INK:
 02B5   0210           TEMP$ = "STOP "
 02BF   0210           CALL BGT.ON:          'in module PC1
 02C8   0210           LOCATE 17,71:COLOR 27,0:PRINT "PRINTING";
 02F1   0210           ACTIVE% = 1
 02F8   0210           RETURN
 02FC   0210
 02FC   0210   STOP.INK:
 0301   0210           TEMP$ = "START"
 0308   0210           CALL BGT.OFF:         'in module PC1
 0317   0210           LOCATE 17,71:COLOR 15,0:PRINT "       ";
 0320   0210           ACTIVE% = 0
 0324   0210           RETURN
 0328   0210
 0328   0210   T1B:          'load reagent profile
 0329   0210           IF KEY$(6,1) = "" THEN LOCATE 22,1:PRINT "Reagent Name is not specified";:GOSUB ANYKEY:RETURN
 0391   0210
 0391   0210           GOSUB SEARCH
 0397   0210
 0397   0210           IF I% < (SEARCH% + 1) THEN GOTO FOUND
 03A8   0214           LOCATE 22,10-LEN(KEY$(6,1))/2:PRINT KEY$(6,1);" not Found";
 03D4   0214           GOSUB ANYKEY:   'wait for a keyhit
 03D8   0214           RETURN
 03DE   0214
 03DE   0214   FOUND:
 0413   0214           FILE$ = RIGHT$(STR$(I%),LEN(STR$(I%))-1) + ".REA.DAT"
 0437   0218           OPEN FILE$ FOR INPUT AS #1:     'set pattern data file for read
 0448   0218           INPUT #1,KEY$(0,0):     'read frequency
 0468   0218           INPUT #1,KEY$(1,0):     'read amplitude
 0489   0218           INPUT #1,KEY$(2,0):     'read strobe delay
 04AE   0218           INPUT #1,KEY$(3,0):     'read pulse width
 04D1   0218           INPUT #1,KEY$(4,0):     'read rise time
 04F4   0218           INPUT #1,KEY$(5,0):     'read fall time
 0519   0218
 0519   0218           INPUT #1,KEY$(7,1):     'read concentration
 0538   0218           INPUT #1,KEY$(8,1):     'read density
 0561   0218           INPUT #1,KEY$(9,1):     'read viscosity
 0585   0218           INPUT #1,KEY$(10,1):    'read surface tension
 05A9   0218
```

```
5 Reagent Jet Printer                                                                    PAGE  6
  Reagent Calibration                                                                    07-14-86
                                                                                         15:24:57
                                                                  IBM Personal Computer BASIC Compiler V2.00

  Offset  Data   Source Line

    0519  0218          CLOSE #1:       'done with data file
10  0520  0218
    0530  0218          OPEN "READIR.BJP" FOR OUTPUT AS #1
    0550  0218          PRINT #1,FILE$:                 'save filename is default file
    0552  0218          PRINT #1,REAGS(6,1):    'save the directory name as well
    0554  0218          CLOSE #1
    0558  0218          GOSUB DISP.PARMS:       'show all parameters
15  0601  0218          RETURN
    0605  0218
    0605  0218  TILE:          'save reagent profile
    0608  0218          IF REAGS(6,1) = "" THEN LOCATE 25,1:PRINT "Reagent Name is not specified";:GOSUB ANYKEY:RETURN
    064E  0218          OPEN "READIR.BJP" FOR INPUT AS #1
    065F  0218          INPUT #1,REAMUMX
20  0671  0218          CLOSE #1
    0678  0218          IF REAMUMX < 80 THEN GOTO SAVE.REA
    0687  0218          LOCATE 25,1:PRINT "Directory is full (80 reagents max.)"
    0691  0218          GOSUB ANYKEY:RETURN
    0698  0218  SAVE.REA:
    0699  0218          GOSUB SEARCH
25  06B6  0218          IF IX > REAMUMX THEN GOTO SAVEREAI
    06C7  0218          REAMUMX = IX
    06CE  0218          COLOR 15,0
    06DA  0218          LOCATE 25,1:PRINT REAGS(6,1);" already exists. Replace it with new values? ";
    070C  0218          A$ = ""
    0716  0218          WHILE A$ = ""
30  0725  0218                A$ = INKEY$
    072F  0218          WEND
    0732  0218          LOCATE 25,1:PRINT SPACE$(79);
    074F  0218          IF A$ = "Y" OR A$ = "y" THEN GOTO REPLACE
    0778  0218          RETURN
    077C  0218
35  077C  0218  SAVEREAI:
    0781  0218          KILL "READIR.OLD":      'delete old backup directory
    0788  0218          NAME "READIR.BJP" AS "READIR.OLD":      'save old directory
    0792  0218          OPEN "READIR.OLD" FOR INPUT AS #1
    079A  0218          OPEN "READIR.BJP" FOR OUTPUT AS #2:     'set up new dir
    07A5  0218
40  07A5  0218          INPUT #1,REAMUMX:       'read number of dir entries
    07C7  0218          REAMUMX = REAMUMX + 1:  'increase by 1
    07D0  0218          WRITE #2,REAMUMX:       'save in new directory
    07E1  0218
    07E1  0218          FOR I=1 TO REAMUMX - 1
45  07F8  021C             LINE INPUT #1,A$:    'read entry from old dir
    0807  021C             PRINT #2,A$:         'write entry in new directory
    0817  021C          NEXT I
    0832  0220
    0832  0220          CLOSE #1
    0839  0220
50  0839  0220          PRINT #2,REAGS(6,1):    'write new entry in new directory
    0858  0220          CLOSE #2:       'done with directory
    0862  0220
    0862  0220  REPLACE:
    0867  0220          FILE$ = RIGHT$(STR$(REAMUMX),LEN(STR$(REAMUMX))-1) + "REA.BJP"
    0888  0220
55
```

```
Offset  Data    Source Line

0883    0220           OPEN FILE$ FOR OUTPUT AS #1:    'create new pattern data file
0899    0220           WRITE #1,REMUS(0,0):      'store frequency
08B3    0220           WRITE #1,REMUS(1,0):      'store amplitude
08DC    0220           WRITE #1,REMUS(2,0):      'store strobe delay
08F3    0220           WRITE #1,REMUS(3,0):      'store pulse width
091E    0220           WRITE #1,REMUS(4,0):      'store rise time
093F    0220           WRITE #1,REMUS(5,0):      'store fall time
09A2    0220
09A2    0220           WRITE #1,REMUS(7,1):      'store concentration
09B4    0220           WRITE #1,REMUS(8,1):      'store density
09A6    0220           WRITE #1,REMUS(9,1):      'store viscosity
09C8    0220           WRITE #1,REMUS(10,1):     'store surface tension
09EA    0220
09EA    0220           CLOSE #1:        'done with data file
09F1    0220
09F1    0220           OPEN "READEF.RJP" FOR OUTPUT AS #1
0A03    0220           PRINT #1,FILE$:                 'save filename in default file
0A13    0220           PRINT #1,REMUS(6,1):     'save the directory name as well
0A35    0220           CLOSE #1
0A3C    0220           RETURN
0A40    0220
0A40    0220    SEARCH:
0A45    0220           OPEN "READIR.RJP" FOR INPUT AS #1
0A56    0220           INPUT #1,REANUM%:        'read number of patterns in dir
0A68    0220           I% = 1:                          'set entry pointer
0A6F    0220
0A6F    0220    SLOOP:
0A74    0220           LINE INPUT #1,A$:        'read next pattern name from dir
0A81    0220           IF A$ = REMUS(6,1) THEN GOTO SEARCH.DONE:        'compare name with dir entry
0A85    0220           I% = I% + 1
0AAE    0220           IF I% < (REANUM% + 1) THEN GOTO SLOOP:'check for done
0AC1    0220    SEARCH.DONE:
0AC6    0220           CLOSE #1
0ACD    0220           RETURN
0AD1    0220
0AD1    0220    T13:           'return with no change to exit reagent calibrate
0AD6    0220           PRINT #3,"UN";
0AE6    0220           CLOSE #3:'       close the channel
0AED    0220           RETURN
0AF1    0220
0AF1    0220    T2:            'process "+" key
0AF6    0220           IF REMU% > 5 THEN RETURN
0B05    0220           NEWTIME = TIMER
0B0F    0224           DELTATIME = NEWTIME - OLDTIME
0B1F    022C           OLDTIME = NEWTIME
0B29    022C           IF DELTATIME > 0.15 THEN MULT% = 1 ELSE MULT% = MULT% + 1
0B4B    022E           IF MULT% > 100 THEN MULT% = 100
0B5B    022E           REMU(REMU%,0) = REMU(REMU%,0) + REMU(REMU%,3) * MULT%:  'add increment
0B9F    022E           IF REMU(REMU%,0) > REMU(REMU%,1) THEN REMU(REMU%,0) = REMU(REMU%,1):    'check max value
0C06    022E           COLOR 15,1:GOSUB DISPREMU:RETURN:
                                                        'show new value
0C1B    022E    T3:            'process "-" key
0C22    022E           IF REMU% > 5 THEN RETURN
0C31    022E           NEWTIME = TIMER
```

```
Offset  Data   Source Line

0C3D    022E         DELTATIME = NEWTIME - OLDTIME
0C4D    022E         OLDTIME = NEWTIME
0C55    022E         IF DELTATIME > 0.15 THEN MULT% = 1 ELSE MULT% = MULT% + 1
0C77    022E         IF MULT% > 100 THEN MULT% = 100
0C89    022E         MENU(MENU%,0) = MENU(MENU%,0) - MENU(MENU%,3) * MULT%:  'sub increment
0CCD    022E         IF MENU(MENU%,0) < MENU(MENU%,2) THEN MENU(MENU%,0) = MENU(MENU%,2):   'check min value
0D32    022E         COLOR 15,1:GOSUB DISPMENU:RETURN:                    'show new value
0D49    022E
0D49    022E   T4:          'process up arrow key
0D4E    022E         IF MENU% MOD 6 = 0 THEN RETURN:              'in top row already
0D63    022E         DIFF% = -1:GOSUB NEWMENU:RETURN:        'move pointer up one
0D74    0230
0D74    0230   T5:          'process down arrow key
0D79    0230         IF MENU% MOD 6 = 5 THEN RETURN:              'in bottom row already
0D8F    0230         DIFF% = 1:GOSUB NEWMENU:RETURN:              'move pointer down one
0DA0    0230
0DA0    0230   T6:          'process left arrow key
0DA5    0230         IF INT(MENU% / 6) = 0 THEN RETURN       'in left column already
0DC5    0230         DIFF% = -6:GOSUB NEWMENU:RETURN:        'move pointer one left
0DD6    0230
0DD6    0230   T7:          'process right arrow key
0DDB    0230         IF INT(MENU% / 6) = 2 THEN RETURN       'in right column already
0DFE    0230         DIFF% = 6:GOSUB NEWMENU:RETURN:              'move pointer one right
0E0F    0230
0E0F    0230   T8:          'input keys into KEYBUF$ until (cr) is entered
0E14    0230         IF MENU% > 10 THEN RETURN
0E23    0230         LOCATE 25,30:COLOR 31,0:PRINT "ENTER NEW VALUE";:COLOR 15,0
0E55    0230         KEYBUF$ = A$
0E5F    0234         WHILE A$ <> CHR$(13)
0E72    0234                LOCATE 25,47:PRINT SPACE$(15);
0E8F    0234                LOCATE 25,47:PRINT KEYBUF$;
0EA9    0234                A$ = ""
0EB3    0234                WHILE A$ = ""
0EC2    0234                       A$ = INKEY$
0ECC    0234                       IF ACTIVE% = 1 AND DEMOTIME < TIMER THEN GOSUB PEN.DOWN
0EF6    0234                WEND
0EF9    0234                IF A$ = CHR$(8) AND LEN(KEYBUF$) > 0 THEN KEYBUF$ = LEFT$(KEYBUF$,LEN(KEYBUF$)-1)
0F3B    0234                IF A$ > CHR$(31) AND LEN(KEYBUF$) < 15 THEN KEYBUF$ = KEYBUF$ + A$
0F75    0234         WEND
0F79    0234
0F79    0234         IF MENU% > 5 THEN GOTO STORESTRING
0F88    0234
0F88    0234         TEMP = VAL(KEYBUF$)      'temp has value of keys input
0F98    0238
0F98    0238         'round off temp according to step size in menu array
0F98    0238         TEMP = INT(TEMP / (MENU(MENU%,3)) + .5) * MENU(MENU%,3)
0FD1    0238
0FD1    0238         'test TEMP for maximum and minimum values in menu array
0FD1    0238         IF TEMP > MENU(MENU%,1) THEN TEMP = MENU(MENU%,1)
1019    0238         IF TEMP < MENU(MENU%,2) THEN TEMP = MENU(MENU%,2)
104F    0238
104F    0238         'insert new value into menu array and update screen
104F    0238         MENU(MENU%,0) = TEMP
1068    0238         LOCATE 25,30:PRINT SPACE$(40);
```

```
Request Jet Printer
Request Calibration                                                      PAGE  7
                                                                         07-14-86
                                                                         12:24:57
Offset  Data    Source Line            IBM Personal Computer BASIC Compiler V2.00

1088    0238            COLOR 0,7:GOSUB DISPMENU
109A    0238            RETURN
109E    0238
109E    0238    SIGNALSTRING:
10A3    0238            MENUS$(MENUI%,1) = KEYBUF$
10BF    0238            LOCATE 23,20:PRINT SPACE$(40);
10DC    0238            COLOR 0,7:GOSUB DISPMENU
10EE    0238            RETURN
10F2    0238
10F2    0238    PEN.DOWN:
10F7    0238            DOWNTIME = TIMER + 1
1107    0238            PRINT #3,"D";
1117    0238            RETURN
111B    0238
111B    0238    ANYKEY:
1120    0238            LOCATE 25,64:PRINT "Strike any key..";
113A    0238            A$ = ""
1144    0238            WHILE A$ = ""
1153    0238                    A$ = INKEY$
115D    0238            WEND
1160    0238            LOCATE 25,1:COLOR 15,0:PRINT SPACE$(79);:COLOR 15,1
1196    0238            RETURN
119A    0238
119A    0238    NEWMENU: 'write old item in yellow, point to and highlight new item
119F    0238            COLOR 14,0:GOSUB DISPMENU
11B1    0238            MENUI% = MENUI% + DIFF%
11BD    0238            IF MENUI% < 11 THEN MENUI% = 10
11CF    0238            IF MENUI% > 15 THEN MENUI% = 15
11E1    0238            COLOR 0,7:GOSUB DISPMENU:RETURN
11F7    0238
11F7    0238    INITIALIZE:
11FC    0238            'change to second screen and display messages
11FC    0238            SCREEN 0,0,1,1:COLOR 7,0:CLS:LOCATE 10,28:PRINT "Initializing Menu Display";
1240    0238            LOCATE 12,33:PRINT "Please wait..."
125A    0238
125A    0238            'initialize variables
125A    0238
125A    0238            ACTIVE% = 0:'  not printing
1261    0238
1261    0238            'initialize plotter com channel
1261    0238
1261    0238            OPEN "COM1:2400,N,8,2" AS #3
1273    0238            PRINT #3,";:UNITS,EFV1,N";
1283    0238
1283    0238            'initialize digital port
1283    0238            SCR% = 4
128A    023A            CALL DIGITAL.OUT(SCR%)
129A    023A            SCR% = 0
12A1    023A            CALL DIGITAL.OUT(SCR%):          'pulse reset line to set amplitude to 0V.
12B1    023A            SCR% = 4
12B8    023A            CALL DIGITAL.OUT(SCR%)
12C8    023A
12C8    023A            'set hardware pulse width
12C8    023A            CALL SET.OUT.WIDTH(5)   'in module PCI
```

Reagent Jet Printer
Reagent Calibration

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07-14-86
12:21:57
IBM Personal Computer BASIC Compiler V2.00

```
Offset- Data   Source Line

12DE   0ZZC
12DE   0ZZC         'initialize some arrays
12DE   0ZZC         RESTORE ARRAYS
12E5   0ZZC         FOR IZ=0 TO 17
12ED   0ZZC                READ MENU$(IZ,0),MENU$(IZ,1):
1318   0ZZC                READ MENU(IZ,1),MENU(IZ,2),MENU(IZ,3),MENU(IZ,4)
137C   0ZZC         NEXT IZ
138F   0ZZC
138F   0ZZC         'set default reagent values
138F   0ZZC
138F   0ZZC         MENU(0,0) = 2000:              'frequency
13A8   0ZZC         MENU(1,0) = 0:                 'amplitude
13C4   0ZZC         MENU(2,0) = 1:                 'strobe delay
13E0   0ZZC         MENU(3,0) = 070:               'pulse width
13FC   0ZZC         MENU(4,0) = 470:               'rise time
1418   0ZZC         MENU(5,0) = 070:               'fall time
1436   0ZZC
1436   0ZZC         MENU(6,0) = 0:                 'name
1452   0ZZC         MENU(7,0) = 0:                 'concentration
146E   0ZZC         MENU(8,0) = 0:                 'density
148A   0ZZC         MENU(9,0) = 0:                 'viscosity
14A6   0ZZC         MENU(10,0) = 0:                      'surface tension
14C2   0ZZC
14C2   0Z3C         OLD.AMP.VALUE% = 0             'initial value of 0 volts
14C9   0ZZE
14C9   0ZZE         'change active displayed screen to first screen to draw and display parameters
14C9   0ZZE
14C9   0ZZE         SCREEN 0,0,0,1:CLS
14E6   0ZZE
14E6   0ZZE         COLOR 13:LOCATE 1,32:PRINT "REAGENT CALIBRATE";
1507   0ZZE         COLOR 9
150E   0ZZE         FOR I=2 TO 79
1518   0ZZE                LOCATE 3,I:PRINT "9";:LOCATE 5,I:PRINT "8";:LOCATE 19,I:PRINT "9";
154F   0Z3E         NEXT I
158A   0ZZE         FOR I=4 TO 18
1594   0ZZE                LOCATE I,1:PRINT "3";:LOCATE I,28:PRINT ":";:LOCATE I,49:PRINT ":";:LOCATE I,80:PRINT "3";
1608   0ZZE         NEXT I
1626   0ZZE         RESTORE TABLE
162D   0ZZE         FOR I=1 TO 12
1637   0ZZE                READ RZ,CZ,KZ:LOCATE RZ,CZ:PRINT CHR$(KZ);
166A   0244         NEXT I
1685   0244
1685   0244         'print three headings and instructions
1685   0244         COLOR 10,0
1691   0244         LOCATE 4,7:PRINT "DROP PARAMETERS";
16A3   0244         LOCATE 4,39:PRINT "REAGENT PARAMETERS"
16C3   0244         LOCATE 4,71:PRINT "COMMANDS";
16DF   0244
16DF   0244         COLOR 7:LOCATE 21,20:PRINT "Use ";:COLOR 15:PRINT CHR$(27);CHR$(32);CHR$(26);
1729   0244         PRINT CHR$(32):CHR$(24);CHR$(32);CHR$(25);:COLOR 7:PRINT " to position highlighted cursor";
1768   0244         LOCATE 22,18:PRINT "Use ";:COLOR 15:PRINT "+";:COLOR 7:PRINT " or ";:COLOR 15:PRINT "-";
17BE   0244         COLOR 7:PRINT" to scroll current value up or down";
17D2   0244         LOCATE 23,24:PRINT "Use ";:COLOR 15:PRINT "CR";:COLOR 7:PRINT" to activate selection";
1814   0244
```

```
Request Jet Printer                                                    PAGE  9
Request Calibration                                                    07-14-86
                                                                       12:26:57
Offset  Data   Source Line                    IBM Personal Computer BASIC Compiler V2.00

1814   0244   DISP.PARTS:
1819   0244           'display IB menu choices in yellow
1819   0244
1819   0244           COLOR 14,0
1825   0244           FOR MENUI = 0 TO 17
1829   0244                   GOSUB DISPMENU
1831   0244           NEXT MENUI
1841   0244
1841   0244           'set for request mode and highlight it
1841   0244           MENUI = 6:COLOR 0,7
1854   0244           GOSUB DISPMENU
185A   0244
185A   0244           SCREEN 0,0,0,0
186F   0244           RETURN
1873   0244   REM $PAGE
```

```
Offset  Data    Source Line

1873    0244    DISPMENU:
1878    0244            LOCATE (MENU% MOD 6)*2+7,(INT(MENU%/6)*28+2)+(5*INT(MENU%/12))
18B4    0244            PRINT MENU$(MENU%,0)
18F2    0244            IF MENU% > 5 THEN GOTO SHOWSTRING:'     no value to display
1901    0244            LOCATE (MENU% MOD 6)*2+7,MENU(MENU%,4)
1933    0244            PRINT USING MENU$(MENU%,1);MENU(MENU%,0);
1966    0244            IF MENU% > 2 THEN RETURN
1975    0244            ON MENU%+1 GOSUB SET.FREQ, SET.AMP, SET.DELAY
19A6    0244            RETURN
19AA    0244    SHOWSTRING:
19AF    0244            IF MENU% > 10 THEN RETURN
19BE    0244            LOCATE (MENU% MOD 6)*2+7,48
19DA    0244            PRINT "          "
19E7    0244            LOCATE (MENU% MOD 6)*2+7,48
19F3    0244            PRINT MENU$(MENU%,1)
1A02    0244            RETURN
1A06    0244
1A06    0244    SET.FREQ:
1A0B    0244            TEMP = MENU(0,0)
1A24    0244            CALL SET.DOT.RATE(TEMP):        'in module PCI
1A34    0244            LED% = 3-INT((TEMP+500)/1000)
1A57    0246            IF LED% < 0 THEN LED% = 0
1A69    0246            SCR% = 4 + (LED% * 32):         'set LED intensity
1A89    0246            CALL DIGITAL.OUT(SCR%):         'in module PCI
1A99    0246            RETURN
1A9D    0246
1A9D    0246    SET.AMP:
1AA2    0246            SCR% = CINT(MENU(MENU%,0) * 255 / 150):        'convert volts to binary number
1AC3    0246            IF SCR% = OLD.AMP.VALUE% THEN RETURN
1ADC    0246            TEMP% = SCR% - OLD.AMP.VALUE%:   'calculate delta
1AEB    0248            OLD.AMP.VALUE% = SCR%:           'update old value to current value
1AEF    0248            DIG.VAL% = 6
1AF6    024A            IF TEMP% < 0 THEN DIG.VAL% = 5
1B08    024A            TEMP% = ABS(TEMP%)
1B15    024A            FOR I% = 1 TO TEMP%
1B22    024C                    SCR% = DIG.VAL% + (32*LED%)
1B3F    024C                    CALL DIGITAL.OUT(SCR%):          'pulse higher or lower
1B4F    024C                    SCR% = 4 + (32 * LED%)
1B6F    024C                    CALL DIGITAL.OUT(SCR%):          'set port to normal
1B7F    024C            NEXT I%
1B91    024C            RETURN
1B95    024C
1B95    024C    SET.DELAY:
1B98    024C            TEMP = MENU(2,0)
1BB6    024C            CALL SET.STROBE.DELAY(TEMP):    'in module PCI
1BC6    024C            RETURN
1BCA    024C
1BCA    024C    REM $PAGE
```

```
 Offset  Byte   Source Line

  19CA   024C   '************ DATA USED BY THIS MODULE ************
  19CA   024C
  19CA   024C   ARRDATA:
  19CF   024C           DATA "Frequency            Hz",10,100,10000,1,1,16
  19D1   024C           DATA "Amplitude             V ",100,150,0,1,19
  19D3   024C           DATA "Strobe Delay         uS",10,100.0,15999.5,.5,.5,16
  19D5   024C           DATA "Pulse Width            ",100,999,0,1,19
  19D7   024C           DATA "Rise Time              ",100,999,0,1,19
  19D9   024C           DATA "Fall Time              ",100,999,0,1,19
  19DB   024C           DATA "Name","",0,0,0,0
  19DD   024C           DATA "Concentration","",0,0,0,0
  19DF   024C           DATA "Density","",0,0,0,0
  19E1   024C           DATA "Viscosity","",0,0,0,0
  19E3   024C           DATA "Surface Tension","",0,0,0,0
  19E5   024C           DATA "","",0,0,0,0
  19E7   024C           DATA "START","",0,0,0,0
  19E9   024C           DATA "LOAD","",0,0,0,0
  19EB   024C           DATA "SAVE","",0,0,0,0
  19ED   024C           DATA "EXIT","",0,0,0,0
  19EF   024C           DATA "","",0,0,0,0
  19F1   024C           DATA "","",0,0,0,0
  19F3   024C
  19F3   024C   TABLE:
  19F3   024C           DATA 3,1,210
  19F6   024C           DATA 3,78,210
  19FC   024C           DATA 3,19,210
  19FE   024C           DATA 3,80,191
  1C00   024C           DATA 5,1,198
  1C02   024C           DATA 5,28,204
  1C04   024C           DATA 5,69,204
  1C06   024C           DATA 5,80,181
  1C08   024C           DATA 19,1,172
  1C0A   024C           DATA 19,28,208
  1C0C   024C           DATA 19,69,208
  1C0E   024C           DATA 19,80,217
  1C10   024C
  1C10   024C   END SUB
  1C17   024C
  1C17   024C
  2EEB-  024C

 50424 Bytes Available
 43168 Bytes Free

     0 Warning Error(s)
     0 Severe  Error(s)
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
0030 0006 REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Pattern Entry/Modif
          ication'
0030 0006 'MODULE  - "PATENT" Pattern creation, modification, and filing
                .
0030 0006 '
0030 0006 'AUTHOR  - M. A. Enevold
0030 0006 '
0030 0006 'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030 0006 '
0030 0006 'REVISION - 1.2 03-10-86 MAE Remove Mouse inputs
0030 0006 '           1.1 02-20-86 MAE Add 80 pattern limit to save
0030 0006 '           1.0 01-13-86 MAE Creation of initial code
0030 0006 '
0030 0006 'SYSTEM  - This code can only be compiled by the BASCOM
0030 0006 '          COMPILER, it will not run under the INTERPRETER!!
0030 0006 '
0030 0006 'DESCRIPTION:
0030 0006 '       This module allows the user to LOAD, SAVE, DIRectory, D
          RAW and
0030 0006 '       enter repeat count and other parameters for a pattern t
          o be printed.
0030 0006 '       The low-resolution graphics mode is selected and a menu
           is displayed
0030 0006 '       across the bottom of the screen.  Using arrow keys
0030 0006 '       point to the action to be taken and then invoke that ac
          tion with the
0030 0006 '       Enter key.  In the DRAW mode, another menu is
0030 0006 '       displayed which allows the user to select from LINE, RE
          CTangle,
0030 0006 '       Solid RECTangle, or CIRCle pattern elements.
0030 0006
0030 0006 'DATA DICTIONARY
0030 0006 '       SCNDATI(50,5)     51 Row (Elements) by 6 Column array f
          or storing pattern elements
0030 0006 '       CURSORI(9)        Storage for cursor graphics icon
0030 0006 '       MENUS(6)          Up to 7 menu names can be saved here
0030 0006 '       ELNUMI            Count of number of elements in a patt
          ern
0030 0006 '       XI  YI            Current location of graphics cursor
0030 0006 '       GRID              Value of one dot space on the screen
          (default is 0.005")
0030 0006 '       ROWI  COLI        Location to print instructions
0030 0006 '       A$                Storage for single key-strokes or inp
          ut strings
0030 0006 '       MENUNUM           Which menu is being displayed (1 or 2
          )
0030 0006 '       ITEM              Pointer to which menu item is highlig
          hted (0 - 6)
0030 0006 '       REPEATI           Number of times pattern is to be repe
          ated when printed
0030 0006 '       IOFF  YOFF        X and Y axis distance between the pri
          nting of repeated patterns
0030 0006 '       ROWSP COLSP       Row and Column spacing for printing m
          ultiple sets of patterns
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
0030  0006  '       PATNUM%                 - Number of patterns stored in
the pattern directory PATDIR.RIP
0030  0006  '       DROW% DCOL%     Row and Column location to display di
rectory entrys
0030  0006  '       NAME$           Pattern name to be LOADed or SAVEd to
 directory
0030  0006  '       I% J%           Counters used to LOAD or SAVE the ele
ment data from/to pattern data file
0030  0006  '       FILE$           Name of pattern data file
0030  0006  '       TEMP%           Which type of element is being drawn.
  1 = Line  2 = Rectangle
0030  0006  '
 3 = Solid Rectangle  4 = Circle
0030  0006  '       FLAG%           Same as TEMP% above
0030  0006  '       START%$$ END%$$$ Message display for startpoint and en
dpoint of element entry
0030  0006  '       I1% Y1%                 Starting cursor position for
element being drawn
0030  0006  '       DI% DY%                 Delta I and Y values used to
re-position cursor after arrow key
0030  0006  '       MAXITEM                 The highest number item in th
e current menu display
0030  0006  '       I$ I$           Starting and ending I position of the
 menu highlighting blue box
0030  0006  '       RADIUS%                 The calculated radius of a ci
rcle to be displayed
0030  0006  REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  3
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    SUB PATENTRY STATIC
 0047   0006
 0047   0006          WIDTH 40:SCREEN 1:CLS
 005F   0006          DIM SCRDATI(50,5),CURSORI(9),MENU$(6)
 0060   029A          ELMUNI = 0:II=0:YI=0:GRID = 0.005
 007F   02A4
 007F   02A4          LINE (0,0)-(6,6),,B
 0081   02A4          LINE (0,3)-(6,3),,B
 00C3   02A4          LINE (3,0)-(3,6),,B
 00E9   02A4          PRESET (3,3)
 00F3   02A4          GET (0,0)-(6,6),CURSORI
 0116   02A4          CLS
 011D   02A4
 011D   02A4          LINE (0,0)-(319,190),,B
 014C   02A4
 0140   02A4          RESTORE INSTRUC
 0147   02A4          FOR I=1 TO 4
 0151   02A4                READ ROWI,COLI,A$
 0164   02AC                LOCATE ROWI,COLI:PRINT A$;
 0180   02AC          NEXT I
 019B   02B0
 019B   02B0    FIRST:
 01A0   02B0          MENUNUM = 1
 01AA   02B4          GOSUB SUBMENU
 01B0   02B4
 01B0   02B4          ON ITEM + 1 GOTO PATDIR, PATLOAD, PATSAVE, PATDRAW, REP
                EAT, PATEXIT
 01CD   02B8          GOTO FIRST
 01D0   02B8
 01D0   02B8    REPEAT:
 01D5   02B8          GOSUB ITEMBOTERASE:     'erase blue box around DIR
 01DB   02B8          LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 01F8   02B8          LOCATE 25,1:INPUT;"Enter Repeat Count  ",REPEATI
 0218   02BA          LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 0235   02BA          LOCATE 25,1:INPUT;"Enter I Axis Offset ",IOFF
 0255   02BE          LOCATE 25,1:PRINT SPACE$(39);   'erase menu line
 0272   02BE          LOCATE 25,1:INPUT;"Enter Y Axis Offset ",YOFF
 0292   02C2          GOTO FIRST
 0296   02C2    PATEXIT:
 0298   02C2          WIDTH 80:SCREEN 0:CLS
 02B2   02C2          EXIT SUB
 02B6   02C2    REM $PAGE
```

Request Jet Printer PAGE 4
Pattern Entry/Modification 07-05-86
10:46:13

Offset	Data	Source Line	IBM Personal Computer BASIC Compiler V2.00
02B6	02C2	PATDIR:	'list directory of patterns
02B8	02C2	GOSUB ITEMBOXERASE:	'erase blue box around DIR
02C1	02C2	LOCATE 25,1:PRINT SPACE$(39);	'erase menu line
02DE	02C2	OPEN "PATDIR.RJP" FOR INPUT AS #1:	'open directory file
02EF	02C2	INPUT #1, PATNUM1:	'read number of patterns in directory
0301	02C4	LINE (1,1)-(318,189),0,BF:	'erase graphics tablet
0326	02C4	I = 0:	'set counter
0330	02C4		
0330	02C4	DISLOOP:	
0335	02C4	I = I + 1:	'set for next value
0344	02C4	IF I > PATNUM1 THEN GOTO DIREXIT:	'test for done
035B	02C4	IF INT((I-1)/44) <> (I-1)/44 THEN GOTO SHOWNEXT	
0384	02C4	IF INT((I-1)/44) < 1 THEN GOTO SHOWNEXT	
03A9	02C4		
03A9	02C4	LOCATE 25,1:PRINT "More to Display. Continue ? (Y or N)";	
03C3	02C4	GOSUB CORLOOP:	'wait for Y or N response
03C9	02C4	IF A$ = "N" THEN GOTO DIREXIT:	'if N then don't continue
03DC	02C4		
03DC	02C4	LINE (1,1)-(318,189),0,BF:	'erase graphics tablet
0401	02C4		
0401	02C4	SHOWNEXT:	
0406	02C4	DROW1 = ((I - 1) MOD 22) + 2:	'calculate row for display
0422	02C4	DCOL1 = 4:	'set column to 4
0429	02C4	IF ((I - 1) MOD 44) > 21 THEN DCOL1 = 23:	'reset column if necessary
044C	02C4		
044C	02C4	LINE INPUT #1, A$:	'read next name from directory
0459	02C4	LOCATE DROW1,DCOL1:PRINT A$;	'PRINT NAME
0475	02C4	GOTO DISLOOP	
0479	02C4		
0479	02C4	DIREXIT:	
047E	02C4	CLOSE #1:	'terminate access to PATDIR.RJP
0485	02C4	GOTO FIRST	
0489	02C4		
0489	02C4	REM $PASS	

```
Offset  Hex   Source Line          IBM Personal Computer BASIC Compiler V2.00
 0489   02C3  PATLOAD:
 048E   02C3          GOSUB ITEMSDIERASE:     'erase blue box around DIR
 0494   02C3          OPEN "PATDIR.RJP" FOR INPUT AS #1
 04A5   02C3          INPUT #1,PATNUMI:       'read number of patterns in dir
 04A7   02C3          GOSUB GETNAME:          'prompt for and input pattern n
                      ame
 04B0   02C8          LINE (1,1)-(318,189),0,BF:      'erase graphics tablet
 04E2   02C8
 04E2   02C8          GOSUB SEARCH
 04E8   02C8
 04E8   02C8          IF I% < (PATNUMI + 1) THEN GOTO FOUND
 04FC   02CA          LOCATE 10,14-(LEN(NAME$)/2):PRINT NAME$;" not Found";
 0531   02CE          LOCATE 12,14:PRINT "Strike Any Key"
 0548   02CE          GOSUB ANYKEY:   'wait for a keyhit
 0551   02CE          GOTO FIRST
 0555   02CE
 0555   02CE  FOUND:
 055A   02CE          FILE$ = RIGHT$(STR$(I%),LEN(STR$(I%))-1) + "PAT.RJP"
 057E   02D2          OPEN FILE$ FOR INPUT AS #1:     'set pattern data file
                      for read
 058F   02D2          INPUT #1,ELNUM%:        'read number of elements in pat
                      tern
 05A1   02D2          INPUT #1,GRID:          'read grid size
 05B3   02D2          INPUT #1,REPEAT%:       'read repeat count
 05C5   02D2          INPUT #1,XOFF:          'read x axis offset for repeat
 05D7   02D2          INPUT #1,YOFF:          'read y axis offset for repeat
 05E9   02D2
 05E9   02D2          FOR I% = 0 TO ELNUM% - 1
 05F7   02D4              FOR J% = 0 TO 5
 05FB   02D4                  INPUT #1,SEGMENT%(I%,J%):'read file into screen
                      array
 0621   02D6              NEXT J%
 0631   02D6          NEXT I%
 0643   02D6          CLOSE #1:       'done with data file
 064A   02D6
 064A   02D6          OPEN "PATDEF.RJP" FOR OUTPUT AS #1
 065C   02D6          PRINT #1,FILE$:                 'save filename in defau
                      lt file
 066C   02D6          PRINT #1,NAME$:                 'save the directory nam
                      e as well
 067C   02D6          CLOSE #1
 0683   02D6
 0683   02D6          GOTO REDRAW
 0687   02D6
 0687   02D6  SEARCH:
 068C   02D6          I% = 1:                         'set entry pointer
 0693   02D6  SLOOP:
 0698   02D6          LINE INPUT #1,A$:       'read next pattern name from di
                      r
 06A5   02D6          IF A$ = NAME$ THEN GOTO SEARCH.END:     'compare name w
                      ith dir entry
 06B8   02D6          I% = I% + 1
 06C1   02D6          IF I% < (PATNUM% + 1) THEN GOTO SLOOP:'check for done
 06D4   02D6  SEARCH.END:
```

Reagent Jet Printer
Pattern Entry/Modification

IBM Personal Computer BASIC Compiler V2.00

```
Offset  Data    Source Line
0609    0226            CLOSE #1:       'not found so close file and display me
                        ssage
06E0    0226            RETURN
06E4    0226
06E4    0226    REM $PAGE
```

```
Offset  Data   Source Line        IBM Personal Computer BASIC Compiler V2.00
 6
 06E4   02D6   PATSAVE:
 06E7   02D6           GOSUB ITEMSOIERASE:     'erase blue box around DIR
 06EF   02D6           IF ELNUM% = 0 THEN GOTO FIRST:  'no elements in pattern
 06FE   02D6   '       OPEN "PATDIR.RJP" FOR INPUT AS #1
10      070F   02D6           INPUT #1,PATNUM%
 0721   02D6           IF PATNUM% < 80 THEN GOTO SAVE.PAT:     'directory full
                 at 80 patterns
 0730   02D6           CLOSE #1
 0737   02D6           LOCATE 25,1:PRINT SPACE$(39);:          'erase bottom l
15                     ine
 0754   02D6           LOCATE 25,1:PRINT "Directory is full (80 patterns max)"
                 ;
 076E   02D6           GOSUB ANYKEY:GOTO FIRST
 0778   02D6   SAVE.PAT:
20      077D   02D6           GOSUB GETNAME:  'prompt for and get pattern name
 0783   02D6           GOSUB SEARCH
 0789   02D6           IF I% > PATNUM% THEN GOTO ADD.NEW.PATTERN
 079A   02D6           LINE (1,1)-(318,189),0,BF:      'erase graphics tablet
 07BF   02D6           LOCATE 10,13-(LEN(NAME$)/2):PRINT NAME$;" already exist
25                     s.";
 07F4   02D6           LOCATE 12,15:PRINT "Replace it?"
 080E   02D6           PATNUM% = I%
 0815   02D6           A$ = ""
 081F   02D6           WHILE A$ = ""
30      082E   02D6                 A$ = INKEY$
 0838   02D6           WEND
 083B   02D6           IF A$ = "Y" OR A$ = "y" THEN GOTO SAVE.PATTERN
 0864   02D6           GOTO FIRST
 0868   02D6
35      0868   02D6   ADD.NEW.PATTERN:
 086D   02D6           KILL "PATDIR.OLD":      'delete old backup directory
 0874   02D6           NAME "PATDIR.RJP" AS "PATDIR.OLD":      'save old direc
                 tory
 087E   02D6           OPEN "PATDIR.OLD" FOR INPUT AS #1
40      088F   02D6           OPEN "PATDIR.RJP" FOR OUTPUT AS #2:     'set up new dir
 08A1   02D6           INPUT #1,PATNUM%:       'read number of dir entries
 08B3   02D6           PATNUM% = PATNUM% + 1:  'increase by 1
 08BC   02D6           WRITE #2,PATNUM%:       'save in new directory
 08CD   02D6           FOR I=1 TO PATNUM% - 1
45      08E6   02DA              LINE INPUT #1,A$:    'read entry from old dir
 08F3   02DA              PRINT #2,A$:         'write entry in new directory
 0903   02DA           NEXT I
 091E   02DA           PRINT #2,NAME$:         'write new entry to new directo
                 ry
50      092E   02DA           CLOSE #1:CLOSE #2:      'done with directory
 093C   02DA   SAVE.PATTERN:
 0941   02DA           FILE$ = RIGHT$(STR$(PATNUM%),LEN(STR$(PATNUM%))-1) + ".P
                 AT.RJP"
 0963   02DA           OPEN FILE$ FOR OUTPUT AS #1:    'create new pattern dat
55                     a file
 0977   02DA           WRITE #1,ELNUM%:        'store number of elements
 0988   02DA           WRITE #1,GRID:          'store grid dimension
 0998   02DA           WRITE #1,REPEAT%:       'store repeat count
 09A9   02DA           WRITE #1,IOFF:          'store x axis offset for repeat
```

IBM Personal Computer BASIC Compiler V2.00

```
Offset  Data    Source Line
0989    02DA            WRITE #1,YOFF:          'store y axis offset for repeat
09C9    02DA            FOR IZ = 0 TO ELMNTS - 1
0907    02DC                FOR JZ = 0 TO 5
0900    02EC                    WRITE #1,SCNDATA(IZ,JZ):        'write screen a
                rray to file
0A03    02EC                NEXT JZ
0A10    02EC            NEXT IZ
0A22    02DC            CLOSE #1:       'done with data file
0A29    02DC            OPEN "PATDEF.RIP" FOR OUTPUT AS #1
0A38    02DC            PRINT #1,FILE$:                 'save filename in defau
                lt file
0A4B    02DC            PRINT #1,NAME$:                 'save the directory nam
                e as well
0A5B    02DC            CLOSE #1
0A62    02DC            GOTO FIRST
0A66    02DC    REM $PAGE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
0A4e    02DC    PATTERN:
0A43    02DC            GOSUB ITEM3OIERASE
0A71    02DC            LINE (1,1)-(319,189),0,BF:      'Erase graphics tablet
0A96    02DC
0A96    02DC    KEITEL:
0A9E    02DC            MENUNUM = 2
0AA5    02DC            GOSUB SUBMENU
0AA8    02DC
0AAB    02DC            ON ITEM + 1 GOTO ALINE, RECT, SRECT, ACIRCLE, REDRAW, B
                ACKUP
0ACE    02DC            GOTO KEITEL
0AC8    02DC
0ACE    02DC    BACKUP:
0AD0    02DC            GOSUB ITEM3OIERASE
0ADe    02DC            GOTO FIRST
0ADA    02DC
0ADA    02DC    ALINE:
0ADF    02DC            TEMP% = 1
0AE6    02DE            STARTMSG$ = "STARTING ENDPOINT"
0AF0    02E2            ENDMSG$ = "ENDING ENDPOINT  "
0AFA    02E6            GOTO ENTERELEMENT
0AFE    02E6
0AFE    02E6    RECT:
0B03    02E6            TEMP% = 2
0B0A    02E6            GOTO RECTMSG
0B0E    02E6
0B0E    02E6    SRECT:
0B13    02E6            TEMP% = 3
0B1A    02E6    RECTMSG:
0B1F    02E6            STARTMSG$ = "STARTING CORNER"
0B29    02E6            ENDMSG$ = "ENDING CORNER  "
0B33    02E6            GOTO ENTERELEMENT
0B37    02E6
0B37    02E6    ACIRCLE:
0B3C    02E6            TEMP% = 4
0B43    02E6            STARTMSG$ = "CENTER OF CIRCLE"
0B4B    02E6            ENDMSG$ = "POINT ON CIRCLE  "
0B57    02E6
0B57    02E6    ENTERELEMENT:
0B5C    02E6            GOSUB ITEM3OIERASE
0B62    02E6            FLAG%=0
0B69    02EB            LOCATE 23,1:PRINT SPACE$(39);
0B86    02EB            LOCATE 23,1:PRINT STARTMSG$;
0BA0    02EB            GOSUB DISPCURSOR
0BA6    02EB    FINDSTART:
0BA8    02EB            GOSUB MOUSEACT
0BB1    02EB            IF A$ = CHR$(27) THEN GOTO ABORT
0BCB    02EB            IF A$ = CHR$(13) THEN GOTO SETSTART
0BCF    02EB            GOSUB CURSORMOVE
0BE3    02EB            GOTO FINDSTART
0BE8    02EB    ABORT:
0BEB    02EB            GOSUB PLACECURSOR
0BF3    02EB            GOTO KEITEL
0BF7    02EB
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
 0BF7  02E8  SETSTART:
 0BFC  02E8          LOCATE 25,1:PRINT ENG$(58);
 0C16  02E8          FLAG% = TEMP1:II% = I%:YI% = Y%
 0C2B  02EC          IF FLAG% = 4 THEN PSET (II%+4,YI%+4)
 0C35  02EC  FINDEND:
 0C3A  02EC          GOSUB MOUSEACT
 0C60  02EC          IF A$ = CHR$(27) THEN GOTO CANCELEL
 0C77  02EC          IF A$ = CHR$(13) THEN GOTO SAVEEL
 0C8E  02EC          GOSUB CURSORMOVE
 0C94  02EC          GOTO FINDEND
 0C97  02EC  CANCELEL:
 0C9C  02EC          GOSUB PLACECURSOR
 0CA2  02EC          ON FLAG% GOSUB ER1, ER2, ER3, ER4
 0CB3  02EC          FLAG% = 0
 0CBA  02EC          GOTO NEXTEL
 0CBE  02EC  SAVEEL:
 0CC3  02EC          GOSUB PLACECURSOR
 0CC9  02EC          IF FLAG% = 4 THEN CIRCLE (II%+4,YI%+4),SQR((I%-II%)^2+(
                     Y%-YI%)^2),,,,1
 0D32  02EC          GOSUB CORRECT
 0D38  02EC          IF A$="N" THEN GOTO RETRAW
 0D48  02EC  STOREEL:
 0D50  02EC          SCNDAT%(ELNUM%,0) = FLAG%
 0D6A  02EC          SCNDAT%(ELNUM%,1) = II%
 0D85  02EC          SCNDAT%(ELNUM%,2) = YI%
 0DA0  02EC          SCNDAT%(ELNUM%,3) = I%
 0DB8  02EC          SCNDAT%(ELNUM%,4) = Y%
 0DD6  02EC          SCNDAT%(ELNUM%,5) = 0
 0DEF  02EC          ELNUM% = ELNUM% + 1
 0DF8  02EC          FLAG% = 0
 0DFF  02EC          GOTO NEXTEL
 0E03  02EC  REM $PAGE
```

```
 Offset  Data   Source Line          IBM Personal Computer BASIC Compiler V2.00
 0E03  02EC   REGRAM:
 0E08  02EC           GOSUB ITEMBOXERASE
 0E0E  02EC           LINE(1,1)-(318,189),0,BF
 0E13  02EC           IF ELMUNT = 0 THEN GOTO NEITEL
 0E42  02EC
 0E42  02EC           FOR I=0 TO ELMUNT-1
 0E5B  02F0                   ON SENDATA(I,0) GOSUB RD1, RD2, RD3, RD4
 0E81  02F0           NEXT I
 0E9C  02F0           GOTO NEITEL
 0EA0  02F0
 0EA0  02F0   '******** Sub-routines called by main module ********
 0EA0  02F0
 0EA0  02F0   SUBMENU:
 0EA5  02F0
 0EA5  02F0           LOCATE 25,1:PRINT SPACE$(39);
 0EC2  02F0           ON MENUNUM GOSUB MENU1, MENU2
 0ED1  02F0
 0ED1  02F0           FOR I=0 TO 6
 0EDB  02F0                   READ MENUS(I)
 0EF2  02F0                   LOCATE 25,(I*6)+2:PRINT MENUS(I);
 0F2B  02F0           NEXT I
 0F46  02F0
 0F46  02F0           READ MAXITEM
 0F4D  02F4           ITEM = 0
 0F57  02F4
 0F57  02F4   NEWITEM:
 0F5C  02F4           GOSUB NEWITEMBOX
 0F62  02F4
 0F62  02F4   NEITITEM:
 0F67  02F4           GOSUB ITEMSEARCH
 0F6D  02F4           IF A$ = CHR$(13) THEN RETURN:'  ITEM has correct value
 0F84  02F4           IF LEN(A$) < 2 THEN BEEP:GOTO NEITITEM
 0F9A  02F4           IF ASC(MID$(A$,2,1)) = 75 THEN GOTO LEFTAR
 0FB6  02F4           IF ASC(MID$(A$,2,1)) = 77 THEN GOTO RIGHTAR
 0FD2  02F4           BEEP:GOTO NEITITEM
 0FD9  02F4
 0FD9  02F4   LEFTAR:
 0FDE  02F4           IF ITEM = 0 THEN GOTO NEITITEM
 0FEE  02F4           GOSUB ITEMBOXERASE
 0FF4  02F4           ITEM = ITEM - 1
 1003  02F4           GOTO NEWITEM
 1007  02F4
 1007  02F4   RIGHTAR:
 100C  02F4           IF ITEM = MAXITEM THEN GOTO NEITITEM
 101F  02F4           GOSUB ITEMBOXERASE
 1025  02F4           ITEM = ITEM + 1
 1034  02F4           GOTO NEWITEM
 1038  02F4
 1038  02F4   MENU1:
 1038  02F4           RESTORE MN1
 1044  02F4           RETURN
 1048  02F4
 1048  02F4   MENU2:
 1048  02F4           RESTORE MN2
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
1034  02F4          RETURN
1038  02F4
1038  02F4    ITEMSEARCH:
1039  02F4          A$ = INKEY$:IF A$ <> "" THEN RETURN
107A  02F4          GOTO ITEMSEARCH
1079  02F4          RETURN
1081  02F4
1081  02F4    NEWITEMBOX:
1086  02F4          IS = (ITEM+40) * 7
109C  02F8          IE = (ITEM+40) * 8 + LEN(MENUS(ITEM))*8
1009  02FC          LINE (IS,191)-(IE,199),1,B
1101  02FC          RETURN
1105  02FC
1105  02FC    ITEMBOXERASE:
110A  02FC          LINE (IS,191)-(IE,199),0,B
1131  02FC          RETURN
1135  02FC
1135  02FC    PLACECURSOR:
113A  02FC          PUT (XI+1,YI+1),CURSOR1
1157  02FC          RETURN
1159  02FC
1159  02FC    MOUSEACT:
1160  02FC          GOSUB ANYKEY
1166  02FC          DXI = 0 : DYI = 0
1174  0300          IF A$ = CHR$(0) + CHR$(72) THEN DYI = -1:RETURN
1190  0300          IF A$ = CHR$(0) + CHR$(80) THEN DYI =  1:RETURN
11C6  0300          IF A$ = CHR$(0) + CHR$(77) THEN DXI =  1:RETURN
11EF  0300          IF A$ = CHR$(0) + CHR$(75) THEN DXI = -1:RETURN
1218  0300          IF A$ = "8" THEN DYI = -20:RETURN
1232  0300          IF A$ = "2" THEN DYI =  20:RETURN
124C  0300          IF A$ = "4" THEN DXI = -20:RETURN
1266  0300          IF A$ = "6" THEN DXI =  20:RETURN
1280  0300          IF A$ = CHR$(27) THEN RETURN
1297  0300          IF A$ = CHR$(13) THEN RETURN
12AE  0300          GOTO MOUSEACT
12B2  0300
12B2  0300    CURSORMOVE:
12B7  0300          GOSUB PLACECURSOR
12B9  0300          ON FLAG% GOSUB ER1, ER2, ER3, ER4
12CE  0300          XI = XI + DXI : YI = YI + DYI
12EA  0300          IF XI < 0 THEN XI = 0
12F9  0300          IF XI > 311 THEN XI = 311
1308  0300          IF YI < 0 THEN YI = 0
1319  0300          IF YI > 182 THEN YI = 182
1338  0300          ON FLAG% GOSUB DR1, DR2, DR3, DR4
1341  0300          GOSUB DISPCURSOR
1347  0300          RETURN
1348  0300
1348  0300    CORRECT:
1350  0300          LOCATE 25,1:PRINT SPACE$(39);
1360  0300          LOCATE 25,1:PRINT "IS THIS CORRECT? (Y or N) ";
1387  0300    CORLOOP:
138C  0300          GOSUB ANYKEY
1392  0300          IF A$ = "y" OR A$ = "Y" THEN A$ = "Y":GOTO COREXIT
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 13C5   0300          IF A$ = "n" OR A$ = "N" THEN A$ = "Y":GOTO CONEXIT
 13F8   0300          GOTO CONLOOP
 13F8   0300    CONEXIT:
 1400   0300          LOCATE 25,1:PRINT SPACE$(39);
 1419   0300          RETURN
 1421   0300
 1421   0300    DISPCURSOR:
 1426   0300          GOSUB PLACECURSOR
 142C   0300          LOCATE 25,27:PRINT USING "+0.###";II * GRID;
 1436   0300          PRINT ",";
 1443   0300          PRINT USING "+0.###";YI * GRID;
 1450   0300          RETURN
 1484   0300
 1484   0300
 1484   0300    RD1:
 1489   0300          LINE(SCNDATI(I,1)+4,SCNDATI(I,2)+4)-(SCNDATI(I,3)+4,SCN
                      DATI(I,4)+4)
 1522   0300          RETURN
 1526   0300
 1526   0300    RD2:
 152B   0300          LINE(SCNDATI(I,1)+4,SCNDATI(I,2)+4)-(SCNDATI(I,3)+4,SCN
                      DATI(I,4)+4),,B
 15C4   0300          RETURN
 15C8   0300
 15C8   0300    RD3:
 15CD   0300          LINE(SCNDATI(I,1)+4,SCNDATI(I,2)+4)-(SCNDATI(I,3)+4,SCN
                      DATI(I,4)+4),,BF
 1667   0300          RETURN
 1668   0300
 1668   0300    RD4:
 1670   0300          RADIUSI = SQR((SCNDATI(I,3)-SCNDATI(I,1))^2 + (SCNDATI(
                      I,4)-SCNDATI(I,2))^2)
 16FF   0302          CIRCLE (SCNDATI(I,1)+4,SCNDATI(I,2)+4),RADIUSI,,,,1
 1750   0302          RETURN
 1761   0302
 1761   0302    DR1:
 1766   0302          LINE (II+4,YI+4)-(II+4,YI+4)
 17AF   0302          RETURN
 17B3   0302
 17B3   0302    DR2:
 17B8   0302          LINE (II+4,YI+4)-(II+4,YI+4),,B
 1801   0302          RETURN
 1805   0302
 1805   0302    DR3:
 180A   0302          LINE (II+4,YI+4)-(II+4,YI+4),,BF
 1854   0302          RETURN
 1858   0302
 1858   0302    DR4:
 185D   0302          RETURN
 1861   0302
 1861   0302    ER1:
 1866   0302          LINE (II+4,YI+4)-(II+4,YI+4),0
 18AF   0302          RETURN
 18B3   0302
```

```
Reagent Jet Printer                                                    PAGE  14
Pattern Entry/Modification                                             07-05-86
                                                                       10:46:13
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 1883   0302   ER2:
 1888   0302           LINE (II%+4,YI%+4)-(II%+4,YI%+4),0,B
 1901   0302           RETURN
 1905   0302
 1905   0302   ER3:
 190A   0302           LINE (II%+4,YI%+4)-(II%+4,YI%+4),0,BF
 1934   0302           RETURN
 1938   0302
 1939   0302   ER4:
 193D   0302           RETURN
 1961   0302
 1961   0302   ANYKEY:
 1966   0302           A$ = ""
 1970   0302           WHILE A$ = ""
 1977   0302                   A$ = INKEY$
 1989   0302           WEND
 198C   0302           RETURN
 1990   0302
 1990   0302   GETNAME:        'prompt for and get filename
 1995   0302           LOCATE 25,1:PRINT SPACE$(39);
 1982   0302           LOCATE 25,38:PRINT "<:";:       'boundry chevron
 19CC   0302           LOCATE 25,1:PRINT "Enter Pattern Name    ";
 19E6   0302           LINE INPUT; "",NAME$
 19F4   0302           RETURN
 19F8   0302
 19F8   0302   ' Data fields used by this module
 19F8   0302
 19F8   0302   MN1:
 19FD   0302           DATA "DIR","LOAD","SAVE","DRAW","REPT","EXIT","",5
 19FF   0302
 19FF   0302   MN2:
 1A04   0302           DATA "LINE","RECT","ERECT","CIRCL","REDRW","MAIN","",5
 1A06   0302
 1A06   0302   INSTRUC:
 1A08   0302           DATA 8,16,"USE ARROWS"
 1A0D   0302           DATA 10,9,"TO SELECT FROM THE MENU"
 1A0F   0302           DATA 14,12,"USE THE ENTER KEY"
 1A11   0302           DATA 16,10,"TO ACTIVATE SELECTION"
 1A13   0302
 1A13   0302   END SUB
 1A1A   0302
 21AF   0302

50426 Bytes Available
43373 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

0000    0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Burr-Brown PCI-2000
                0 custom driver'
0030    0006    'MODULE   - 'PCI' Driver for the PCI-20000 I/O and PULSE cards
0030    0006    '
0030    0006    'AUTHOR   - M. S. Fairchild of Computing Architects Inc.
0030    0006    '                                  113 Fairfield Way
0030    0006    '                                  Bloomingdale, IL 60108
0030    0006    '                                  312/980-6777
0030    0006    '
0030    0006    'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030    0006    '
0030    0006    'REVISION - 1.2 12-16-85 MSF Add digital I/O initalization, and
                output routine
0030    0006    '
0030    0006    '         - 1.1 12-10-85 MSF Move counter module to position 2
0030    0006    '
0030    0006    '         - 1.0 11-22-85 MSF Creation of initial code
0030    0006    '
0030    0006    'SYSTEM   - This code can only be compiled by the BASCOM V2
0030    0006    '           COMPILER, it will not run under the INTERPRETER!!
0030    0006    '
0030    0006    'DESCRIPTION:
0030    0006    '               The PCI module is a group of routines used to a
                ccess
0030    0006    '       the BURR-Brown PCI-20000 board. The supplied software c
                auses
0030    0006    '       the Wordstar2000 software to malfunction and will not p
                rivide
0030    0006    '       explicit on, off functions for the counters.  Custom dr
                ivers
0030    0006    '       will be made to provide all of the desired functions.
0030    0006    '
0030    0006    '
0030    0006    '       Address         Register
0030    0006    '       &HC0000 Carrier I.D. / module present (R)
0030    0006    '       &HC0040 Module interrupt status (R)
0030    0006    '       &HC0080 Digital I/O port 0 (R/W)
0030    0006    '       &HC0081 Digital I/O port 1 (R/W)
0030    0006    '       &HC0082 Buffer direction and enable (R/W)
0030    0006    '       &HC0083 Control for ports 0 and 1 (W)
0030    0006    '       &HC00C0 Digital I/O port 2 (R/W)
0030    0006    '       &HC00C1 Digital I/O port 3 (R/W)
0030    0006    '       &HC00C3 Control for ports 2 and 3 (W)
0030    0006
0030    0006    '       &HC0200         Read module I.D. (1110 1010)
0030    0006    '       &HC0204         Rate generator low-order 16 bits (0)
0030    0006    '       &HC0205         Rate generator high-order 16 bits (1)
0030    0006    '       &HC0206         Counter 3 count register (2)
0030    0006    '       &HC0207         Rate generator/counter 3 control
0030    0006    '       &HC0208         Counter 0 count register (0)
0030    0006    '       &HC0209         Counter 1 count register (1)
0030    0006    '       &HC020A         Counter 2 count register (2)
0030    0006    '       &HC020B         Counter 0 - 2 control
0030    0006    '       &HC020C         Counter gate control (1 enables, 0 disa
```

```
Offset  Data    Source Line
                bits:
0030    0006    '               bit     function
0030    0006    '               0       Rate generator gate
0030    0006    '               1       Rate generator gate
0030    0006    '               2       Counter 0 gate
0030    0006    '               3       Counter 1 gate
0030    0006    '               4       Counter 2 gate
0030    0006    '               5       Counter 3 gate
0030    0006    '               6       Not used
0030    0006    '               7       Not used
0030    0006    '
0030    0006    '
0030    0006    'DATA DICTIONARY
0030    0006    '
0030    0006    '       COUNT   - Divisor to 2Mhz rate to give desired frequenc
                y or time
0030    0006    '       COUNTMZ         - High order 16 bits of a 32 bit divisor
0030    0006    '       COUNTLZ - Low order 16 bits of a 32 bit divisor
0030    0006    '       LSBZ    - Lower 8 bits of a 16 bit divisor
0030    0006    '       MSBZ    - Upper 8 bits of a 16 bit divisor
0030    0006
0030    0006    ' Main line code
0030    0006    '       The main line code is never executed. It's sole purpose
                 is to
0030    0006    ' declare shared the variables that will be used in the subrout
                ines
0030    0006    ' so that they will all be defined and hold their values.
0030    0006
0030    0006    MAIN:
0030    0006            DIM SHARED COUNT,COUNTMZ,COUNTLZ,LSBZ,MSBZ
0030    0006
0030    0006    MAINLOOP:
0030    0006            GOTO MAINLOOP
004C    0012
004C    0017    REM SPACE
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
                '
004C    0012    'SUBROUTINE     - PCI.INIT
004C    0012    '
004C    0012    'DESCRIPTION:
004C    0012    '       The PCI.INIT subroutine initalizes the PCI hardware.
004C    0012
004C    0012    DEF PCI.INIT STATIC
0053    0012
0053    0012            DEF SEG = &HC000: 'Point segment to PCI-20000 board
005A    0012
005A    0012            POKE &HC20C,&H00: 'Disable all software enabled counter
                s
0063    0012
0063    0012    ' Configure rate generator to 2 Mhz
0063    0012
0063    0012            POKE &H0207,&H34: 'Set low rate counter to mode 2
0069    0012            POKE &H0207,&H74: 'Set high rate counter to mode 2
0077    0012            POKE &H0204,&H02: 'Load low rate counter with 16 bits o
                f 2
0081    0012            POKE &H0204,&H00
008A    0012            POKE &H0205,&H02: 'Load high rate counter with 16 bits
                of 2
0094    0012            POKE &H0205,&H00
0099    0012            POKE &H020C,&H03: 'Enable rate counters
00A7    0012
00A7    0012    ' Configure dot rate counters (default to 5 Khz)
00A7    0012
00A7    0012            POKE &H0208,&H34: 'Set low dot counter (0) to mode 2
00B1    0012            POKE &H0208,&H74: 'Set high dot counter (1) to mode 2
00BB    0012            POKE &H0208,&H04: 'Load low rate counter with 16 bits o
                f 4
00C5    0012            POKE &H0209,&H00
00CE    0012            POKE &H0209,&H64: 'Load high rate counter with 16 bits
                of 100
00D8    0012            POKE &H0209,&H00
00E1    0012
00E1    0012    ' Configure dot pulse with one shot (default to 13 usec)
00E1    0012
00E1    0012            POKE &H0203,&H02: 'Set dot pulse with oneshot (2) to mo
                de 1
00EB    0012            POKE &H020A,&H1A: 'Load oneshot with 16 bits of 26
00F5    0012            POKE &H020A,&H00
00FE    0012
00FE    0012    ' Configure shifted strobe pulse one shot (default to .5 usec)
00FE    0012
00FE    0012            POKE &H0207,&HB2: 'Set shifted strobe onshot (3) to mod
                e 1
0108    0012            POKE &H0206,&H01: 'Load oneshot with 16 bits of 1
0112    0012            POKE &H0206,&H00
0118    0012
0118    0012    ' Configure port 0 to output and port 1 to input
0118    0012
0118    0012            POKE &H0083,&H82: ' Set up I/O chip
0123    0012            POKE &H0082,&HC4: ' Set up direction and enable buffers
012F    0012            POKE &H0080,&H00: ' Dissable print head
```

```
Reagent Jet Printer                                                    PAGE  4
Burr-Brown PCL-[illegible] custom driver                               04-30-86
                                                                       08:38:16
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 013B   0012          END SUB
 013F   0012
 013F   0012    REM $PASSIF:12
 013F   0012    'SUBROUTINE     - DOT.ON
 013F   0012    '
 013F   0012    'DESCRIPTION:
 013F   0012    '       The DOT.ON subroutine enables the dot frequency counter
                s.
 013F   0012
 013F   0012    SUB DOT.ON STATIC
 0146   0012
 0146   0012          POKE &H020C,&H0F: 'Enable dot counters and rate generat
                or
 0150   0012
 0150   0012          END SUB
 0157   0012
 0157   0012    REM $PASSIF:12
 0157   0012    'SUBROUTINE     - DOT.OFF
 0157   0012    '
 0157   0012    'DESCRIPTION:
 0157   0012    '       The DOT.OFF subroutine disables the dot counters
 0157   0012
 0157   0012    SUB DOT.OFF STATIC
 015E   0012
 015E   0012          POKE &H020C,&H03: 'Disable dot counters and enable rate
                 generator
 0168   0012
 0168   0012          END SUB
 016F   0012
 016F   0012    REM $PASSIF:49
```

```
Offset  Data    Source Line
016F    0012    'SUBROUTINE     - SET.DOT.RATE
016F    0012    '
016F    0012    'DESCRIPTION:
016F    0012    '       The SET.DOT.RATE subroutine loads the dot rate counters
016F    0012    ' with the desired dot frequency. Allowed range is 10,000 to 1
                Hz.
016F    0012    ' The FREQ parameter is a real number in Hz.
016F    0012
016F    0012    SUB SET.DOT.RATE(FREQ) STATIC
0176    0012
0176    0012    ' Limit freqency to in range
0176    0012
0176    0012            IF FREQ < 1 THEN FREQ = 1
018F    0012            IF FREQ > 10000 THEN FREQ = 10000
01A8    0012
01A8    0012    ' Convert to count and check for 16 bit count or 32 bit count
01A8    0012
01A8    0012            COUNT = 2E6 / FREQ
01B8    0012            IF COUNT < 65536! THEN GOTO DIVIDE16 ELSE GOTO DIVIDE32
01CF    0012
01CF    0012    ' Process count of 32 bits
01CF    0012
01CF    0012    DIVIDE32:
0180    0012            COUNTL1 = INT((COUNT/32768!) + 1): 'Stage lower count
01F0    0012            COUNTH1 = INT(COUNT/COUNTL1): 'Form upper count
020B    0012            GOTO SET.COUNT
020F    0012
020F    0012    ' Process count of 16 bits
020F    0012
020F    0012    DIVIDE16:
0214    0012            COUNTL1 = 2
0218    0012            COUNTH1 = INT(COUNT/2)
0232    0012            GOTO SET.COUNT
0236    0012
0236    0012    ' Send the derived counts out to the counters
0236    0012
0236    0012    SET.COUNT:
0237    0012            LSB1 = COUNTL1 MOD 256: ' Send out low 16 bits
0248    0012            MSB1 = INT(COUNTL1 / 256)
025B    0012            POKE &H0208,LSB1
0273    0012            POKE &H0208,MSB1
028B    0012
028B    0012            LSB1 = COUNTH1 MOD 256: 'Send out high 16 bits
0291    0012            MSB1 = INT(COUNTH1 / 256)
02AC    0012            POKE &H0209,LSB1
02BC    0012            POKE &H0209,MSB1
02CC    0012
02CC    0012            END SUB
02D3    0012
02D3    0012    REM $PAGEIF:27
```

Reagent Jet Printer PAGE 6
Burr-Brown PCI-20000 custom driver 04-30-86
08:23:16

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
02D3  0012  'SUBROUTINE     - SET.DOT.WIDTH
02DC  0012  '
02D3  0012  'DESCRIPTION:
02D3  0012  '       The SET.DOT.WIDTH subroutine loads the dot width one sh
            ot
02D3  0012  ' with the desired dot pulse width. Allowed range is .5 to 16,0
            00 usec.
02D3  0012  ' The dwidth parameter is a real number in usec.
02D3  0012
02D3  0012  SUB SET.DOT.WIDTH(DWIDTH) STATIC
02DA  0012
02DA  0012  ' Limit width to in range
02DA  0012
02DA  0012          IF DWIDTH < .5 THEN DWIDTH = .5
02F3  0012          IF DWIDTH > 16000 THEN DWIDTH = 16000
030C  0012
030C  0012  ' Convert to count
030C  0012
030C  0012          COUNT = DWIDTH / .5
031A  0012
031A  0012  ' Send the derived count out to the counter
031A  0012
031A  0012          LSB% = INT(COUNT MOD 256): ' Send out 16 bits
0331  0012          MSB% = INT(COUNT / 256)
0348  0012          POKE &H020A,LSB%
0358  0012          POKE &H020A,MSB%
0368  0012
0368  0012          END SUB
036F  0012
036F  0012  DEF SEGIF:27
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
036F 0012  'SUBROUTINE     - SET.STROBE.DELAY
036F 0012  '
036F 0012  'DESCRIPTION:
036F 0012  '       The SET.STROBE.DELAY subroutine loads the strobe delay one shot
036F 0012  ' with the desired strobe delay time. Allowed range is .5 to 16,000 usec.
036F 0012  ' The delay parameter is a real number in usec.
036F 0012
036F 0012  SUB SET.STROBE.DELAY(DELAY) STATIC
0376 0012
0376 0012  ' Limit delay to in range
0376 0012
0376 0012          IF DELAY < .5 THEN DELAY = .5
038F 0012          IF DELAY > 16000 THEN DELAY = 16000
03A8 0012
03A8 0012  ' Convert to count
03A8 0012
03A8 0012          COUNT = DELAY / .5
03B6 0012
03B6 0012  ' Send the derived count out to the counter
03B6 0012
03B6 0012          LSB% = INT(COUNT MOD 256): ' Send out 16 bits
03CD 0012          MSB% = INT(COUNT / 256)
03E4 0012          POKE &H0206,LSB%
03F4 0012          POKE &H0206,MSB%
0404 0012
0404 0012          END SUB
040B 0012
040B 0012  REM $PAGEIF:16
040B 0012  'SUBROUTINE     - DIGITAL.OUT
040B 0012  '
040B 0012  'DESCRIPTION:
040B 0012  '       The DIGITAL.OUT subroutine sends the passed integer to the output
040B 0012  '        port 0.
040B 0012
040B 0012  SUB DIGITAL.OUT(BYTE%) STATIC
0412 0012
0412 0012  ' Send the byte to the port
0412 0012
0412 0012          POKE &H0080,BYTE%
0423 0012
0423 0012          END SUB
042A 0012
057F 0012

50426 Bytes Available
48723 Bytes Free

   0 Warning Error(s)
   0 Severe  Error(s)
```

```
Request Jet Printer                                                    PAGE
Pattern Printing                                                       09-1
                                                                       09:4
 Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V
0010  0004  REM $TITLE:"Request Jet Printer" $SUBTITLE:"Pattern Printing" FLAGS$SIZE:1:2
0010  0004  '$TITLE  - "PATTERN"
0010  0004  '
0010  0004  '$AUTHOR  - R. A. Ewald
0010  0004  '
0010  0004  '$COPYRIGHT (C) 1985 ARTSCI LABORATORIES
0010  0004  '
0010  0004  '$REVISION - 2.0 07-02-86 RAE Modified for Microfab Printhead
0010  0004  '         - 1.1 03-07-86 RAE Added notes and final touches
0010  0004  '           1.0 02-03-86 RAE Creation of initial code
0010  0004  '
0010  0004  '$STATUS  - This code can only be compiled by the BASCOM
0010  0004  '           COMPILER, it will not run under the INTERPRETER!!
0010  0004  '
0010  0004  '$DESCRIPTION:
0010  0004  '       The printing module displays a menu in 3 columns of 4 rows each. The first
0010  0004  '       column has data from the default request profile. The second column has
0010  0004  '       data from the default pattern file. The third column has standard printing
0010  0004  '       data. The four arrow keys allow different menu items to be highlighted and
0010  0004  '       the values can be changed with the + or - keys or by entering the new number
0010  0004  '       followed by Enter. P will cause the pattern to be printed, S will select the
0010  0004  '       notepad, and E will exit to the main program. On the notepad, any single line
0010  0004  '       entered here will be sent to the printer. A null line exits the notepad.
0010  0004  '
0010  0004  '$DATA DICTIONARY
0010  0004  '       PICKIT          Which menu item is highlighted (0-17)
0010  0004  '       DIFF%           Where to move menu highlight in response to arrow key
0010  0004  '       TYPE%           What key has been pressed during main scan
0010  0004  '       ELEMENT         Number of elements in current pattern
0010  0004  '       SELECTT(25,2)   Array for storing elements in current pattern
0010  0004  '       REPEAT%         Counter for repeat printing the pattern
0010  0004  '       CT%             Counter for stepping through the pattern array during printing
0010  0004  '       RADIUS%         Radius of circle during printing
0010  0004  '       I% J%           Offsets for start row/column position
0010  0004  '       REPI% REPJ%     Repeat distances for repeat printing of patterns
0010  0004  '       SI% SJ%         Starting I and J positions for solid rectangles
0010  0004  '       EI% EJ%         Ending I and J positions for solid rectangles
0010  0004  '       I% J%           Counters used for reading pattern files into the array
0010  0004  '       TEMP%           Register for misc. integers
0010  0004  '       NOTELINE%       Pointer to which line is active in the notepad
0010  0004  '       MENU$(17,1)     Array of strings used to display menu items
0010  0004  '       A$              Single keystroke input destination
0010  0004  '       ENTER$          String entered in notepad and sent to printer
0010  0004  '       KEYIN$          String entered from main scan and assigned to number of string field
0010  0004  '       REQNAME$        Name of default request
0010  0004  '       PATNAME$        Name of default pattern
0010  0004  '       FILE$           Name of request data file and then pattern data file
0010  0004  '       NEW%(11,4)      Array of values used in displaying menu item numbers
0010  0004  '       TEMP            Register for the temporary storage of real numbers
0010  0004  REM $PAGE
```

Respect Jet Printer
Pattern Printing

PAGE
09-1
08:4
IBM Personal Computer BASIC Compiler V.

```
Offset  Data   Source Line

0024    0066   SUB PATPRINT STATIC
0047    0066
0047    0066          DIM SCRDAT%(50,3),RENU$(17,1),RENU(17,4)
0048    0462
0048    0462          GOSUB INITIALIZE:       'read init. values and set screen
004E    0462
004E    0462          WHILE TYPE% <> 1
0059    0464
0059    0464            TYPE% = 0
0060    0464            A$ = ""
006A    0468
006A    0468            WHILE A$ = ""
0079    0468              A$ = INKEY$
0083    0468            WEND
008A    0468
008A    0468            IF A$ = "E" OR A$ = "e" THEN TYPE% = 1:        'exit sub
00B2    0468            IF A$ = "P" OR A$ = "p" THEN TYPE% = 2:        'print pattern
00DE    0468            IF A$ = "+" THEN TYPE% = 3:                    'increment variable
00F4    0468            IF A$ = "-" THEN TYPE% = 4:                    'decrement variable
010A    0468            IF A$ = CHR$(0) + CHR$(72) THEN TYPE% = 5:     'up arrow key
012F    0468            IF A$ = CHR$(0) + CHR$(80) THEN TYPE% = 6:     'down arrow key
0154    0468            IF A$ = CHR$(0) + CHR$(75) THEN TYPE% = 7:     'left arrow key
0179    0468            IF A$ = CHR$(0) + CHR$(77) THEN TYPE% = 8:     'right arrow key
019E    0468            IF A$ > CHR$(47) AND A$ < CHR$(58) THEN TYPE% = 9:' number 0-9
01D6    0468            IF A$ = "S" OR A$ = "s" THEN TYPE% = 10:       'enter scratchpad
0202    0468
0202    0468            ON TYPE% GOSUB T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
021F    0468
021F    0468          WEND
0223    0468          TYPE% = 0
022A    0468
022A    0468          EXIT SUB
022E    0468
022E    0468   '*********** SUBROUTINES FOR THIS MODULE ***********
022E    0468   T10:   'scratch pad
0233    0468          SCREEN 0,0,2,2:COLOR 7,0
0254    0468          LOCATE NOTELINE%,1
0264    046A   NOTELOOP:
0269    046A          LINE INPUT NOTE$
0277    046E          IF NOTE$ = "" THEN SCREEN 0,0,0,0:RETURN
029F    046E          LPRINT NOTE$
02AC    046E          IF NOTELINE% < 24 THEN NOTELINE% = NOTELINE% + 1
02C0    046E          GOTO NOTELOOP
02C3    046E
02C3    046E
02C3    046E   T1:
02C8    046E          RETURN:                  'exit to print menu, no action
02CC    046E
02CC    046E   T3:          'process "+" key
02D1    046E          IF RENU(RENUM%,0) >= RENU(RENUM%,1) THEN RENU(RENUM%,0) = RENU(RENUM%,1):RETURN:    'check max value
033C    0470          RENU(RENUM%,0) = RENU(RENUM%,0) + RENU(RENUM%,2):  'add increment
0372    0470          COLOR 0,7:GOSUB DISPRENU:RETURN:                 'show new value
0388    0470
0388    0470   T4:          'process "-" key
```

```
0?3C  0470         IF MENU(MENUPT%,0) <= MENU(MENUPT%,2) THEN MENU(MENUPT%,0) = MENU(MENUPT%,2):RETURN:   'check min value
0?3?  0470         MENU(MENUPT%,0) = MENU(MENUPT%,0) - MENU(MENUPT%,3):  'sub increment
043E  0470         COLOR 0,7:GOSUB DISPMENU:RETURN:                          'show new value
0444  0470
0444  0470   T5:          'process up arrow key
0449  0470         IF MENUPT% MOD 6 = 0 THEN RETURN:              'in top row already
045E  0470         DIFF% = -1:GOSUB NEWMENU:RETURN:          'move pointer up one
046F  0472
046F  0472   T6:          'process down arrow key
0474  0472         IF MENUPT% MOD 6 = 5 THEN RETURN:              'in bottom row already
0482  0472         DIFF% = 1:GOSUB NEWMENU:RETURN:                'move pointer down one
049B  0472
049B  0472   T7:          'process left arrow key
04A0  0472         IF INT(MENUPT% / 6) = 0 THEN RETURN       'in left column already
04C0  0472         DIFF% = -6:GOSUB NEWMENU:RETURN:          'move pointer one left
04D1  0472
04D1  0472   T8:          'process right arrow key
04D6  0472         IF INT(MENUPT% / 6) = 2 THEN RETURN       'in right column already
04F9  0472         DIFF% = 6:GOSUB NEWMENU:RETURN:                   'move pointer one right
050A  0472
050A  0472   T9:          'input keys into KEYBUF$ until (cr) is entered
050F  0472         LOCATE 25,30:COLOR 31,0:PRINT "ENTER NEW VALUE";:COLOR 15,0
0541  0472         KEYBUF$ = A$
054B  0476         WHILE A$ <> CHR$(13)
055E  0476                LOCATE 25,47:PRINT SPACE$(20);
0578  0476                LOCATE 25,47:PRINT KEYBUF$;
0595  0476                A$ = ""
059F  0476                WHILE A$ = ""
05AE  0476                       A$ = INKEY$
05B8  0476                WEND
05BB  0476                IF A$ = CHR$(8) AND LEN(KEYBUF$) > 0 THEN KEYBUF$ = LEFT$(KEYBUF$,LEN(KEYBUF$)-1)
05FB  0476                IF A$ > CHR$(31) THEN KEYBUF$ = KEYBUF$ + A$
061E  0476         WEND
0622  0476         TEMP = VAL(KEYBUF$)      'temp has value of keys input
0632  047A
0632  047A         'round off temp according to step size in menu array
0632  047A         TEMP = INT(TEMP / (MENU(MENUPT%,3)) + .5) * MENU(MENUPT%,3)
066B  047A
066B  047A         'test TEMP for maximum and minimum values in menu array
066B  047A         IF TEMP > MENU(MENUPT%,1) THEN TEMP = MENU(MENUPT%,1)
06A8  047A         IF TEMP < MENU(MENUPT%,2) THEN TEMP = MENU(MENUPT%,2)
06E7  047A
06E7  047A         'insert new value into menu array and update screen
06E7  047A         MENU(MENUPT%,0) = TEMP
0705  047A         LOCATE 25,30:PRINT SPACE$(40);
072C  047A         COLOR 0,7:GOSUB DISPMENU
0734  047A         RETURN
0738  047A
0738  047A   T2:   'set Burr-Brown board then print desired pattern
0738  047A
0738  047A         BEEP:COLOR 15,0:LOCATE 25,1
075A  047A         PRINT "Set Potentiometers on Printer....then Press any Key";
0767  047A         A$ = ""
0771  047A         WHILE A$ = ""
```

6 Pasquet Jet Printer
Pattern Printing

PAGE
09-17
08:49
IBM Personal Computer BASIC Compiler V2

```
Offset  Data    Source Line

0780    047A            A$ = INKEY$
078A    047A        WEND
078B    047A        LOCATE 25,1:PRINT SPACE$(79);
07AA    047A
07AA    047A        'enter drop parameters into burr-brown board
07AA    047A        TEMP = MENU(0,0):CALL SET.DOT.RATE(TEMP)
07D3    047A        TEMP = 5:CALL SET.DOT.WIDTH(TEMP)
07ED    047A        TEMP = MENU(2,0):CALL SET.STROKE.DELAY(TEMP)
0819    047A        CALL DOT.ON
0825    047A
0825    047A        TEMP% = 4
082C    047C        CALL DIGITAL.OUT(TEMP%)
083C    047C        TEMP% = 0:                  'pulse RESET line
0843    047C        CALL DIGITAL.OUT(TEMP%)
0853    047C        TEMP% = 4
085A    047C        CALL DIGITAL.OUT(TEMP%)
086A    047C
086A    047C        J% = CINT(MENU(1,0) * 255 / 150): 'set pulse amplitude by pulsing HIGHER signal J% number of times
0893    047E        FOR I% = 1 TO J%
08A0    0480                TEMP% = 6:          'set HIGHER true
08A7    0480                CALL DIGITAL.OUT(TEMP%)
08B7    0480                TEMP% = 4:          'set HIGHER false
08BE    0480                CALL DIGITAL.OUT(TEMP%)
08CE    0480        NEXT I%
08E0    0482
08E0    0482        'establish COM1: and initialize plotter
08E0    0482        OPEN "COM1:2400,E,8,2,CS ASC33" AS #1
08F2    0482        PRINT #1,";:UECS,S791,A";
0902    0482
0902    0482        'save nozzle offset and establish new origin
0902    0482        PRINT #1,"A0";
0912    0482
0912    0482        'calculate row/column location, move there, and set new origin
0912    0482        X% = (MENU(12,0)-1) * (MENU(14,0) / 0.005)
0934    0484        Y% = (MENU(13,0)-1) * (MENU(15,0) / 0.005)
0996    0486        PRINT #1,X%;Y%;"O";
09B4    0486
09B4    0486        'print the pattern using repeat count
09B4    0486        REPY% = MENU(8,0) / 0.005
09D7    0488        REPX% = MENU(9,0) / 0.005
09FA    048A
09FA    048A        FOR REPEAT% = 0 TO MENU(7,0)
0A1C    048C
0A1C    048C                'print the pattern
0A1C    048C                FOR CT% = 0 TO CLNUM% - 1
0A2A    0490                        ON SCADAT%(CT%,0) GOSUB PLINE, PRECT, PSRECT, PCIRCL
0A4C    0492                NEXT CT%
0A5E    0492
0A5E    0492                PRINT #1,"H,0,0,";:     'return to origin
0A6E    0492                PRINT #1,REPX%;REPY%;"O";: 'move to next pattern
0A8C    0492        NEXT REPEAT%
0AA1    0494
0AA1    0494        PRINT #1,"H";:  'return plotter to original MODE
0AB1    0494
```

```
Request Jet Printer
Pattern Printing                                                                    PAGE
                                                                                    09-17
                                                                                    08:49
Offset  Data    Source Line                                  IBM Personal Computer BASIC Compiler V2

0A31  0A94            CLOSE #1:       'disable call
0A38  0A94
0A41  0A94            RETURN
0A3C  0A94
0A3C  0A94    PLINE:
0A41  0A94            PRINT #1,SCRDATI(CTI,2);SCRDATI(CTI,1);'D';
0A03  0A94            PRINT #1,SCRDATI(CTI,4);SCRDATI(CTI,3);'U';
0A45  0A94            RETURN
0A49  0A94
0A49  0A94    PLOT:
0A4E  0A94            PRINT #1,SCRDATI(CTI,2);SCRDATI(CTI,1);'D';
0A90  0A94            PRINT #1,SCRDATI(CTI,4);SCRDATI(CTI,1);
0ACC  0A94            PRINT #1,SCRDATI(CTI,4);SCRDATI(CTI,3);
0AD8  0A94            PRINT #1,SCRDATI(CTI,2);SCRDATI(CTI,3);
0AE4  0A94            PRINT #1,SCRDATI(CTI,2);SCRDATI(CTI,1);'U';
0AE6  0A94            RETURN
0AEA  0A94
0AEA  0A94    PCIRCL:
0AEF  0A94            RADIUSI = SQR((SCRDATI(CTI,2)-SCRDATI(CTI,1))^2 + (SCRDATI(CTI,4)-SCRDATI(CTI,2))^2)
0B1A  0A96            PRINT #1,'BE ';SCRDATI(CTI,2);SCRDATI(CTI,1);RADIUSI;
0B63  0A96            RETURN
0B67  0A96
0B67  0A96    PSELECT:
0B6C  0A96            SII = SCRDATI(CTI,1):EII = SCRDATI(CTI,2)
0B80  0A9E            STI = SCRDATI(CTI,2):ETI = SCRDATI(CTI,1)
0BD4  0A9E            IF EII <= SII THEN SII = SCRDATI(CTI,2):EII = SCRDATI(CTI,4)
0BE5  0A9E            IF ETI <= STI THEN STI = SCRDATI(CTI,1):ETI = SCRDATI(CTI,3)
0BEA  0A9E
0BEA  0A9E            PRINT #1,SII;STI;'D';
0E74  0A9E
0E74  0A9E            IF EII - SII >= ETI - STI THEN GOSUB STEPY ELSE GOSUB STEPX
0E90  0A9E
0E90  0A9E            PRINT #1,'U';
0EAD  0A9E            RETURN
0EB1  0A9E
0EB1  0A9E    STEPX:
0EB6  0A9E            PRINT #1,EII;STI;
0ECC  0A9E            STI = STI + 1
0ED7  0A9E            IF STI > ETI THEN RETURN
0EEB  0A9E            PRINT #1,EII;STI;SII;STI;
0F0E  0A9E            STI = STI + 1
0F17  0A9E            IF STI > ETI THEN RETURN
0F28  0A9E            PRINT #1,SII;STI;
0F40  0A9E            GOTO STEPY
0F44  0A9E
0F44  0A9E    STEPY:
0F49  0A9E            PRINT #1,SII;ETI;
0F61  0A9E            SII = SII + 1
0F6A  0A9E            IF SII > EII THEN RETURN
0F78  0A9E            PRINT #1,SII;ETI;SII;STI;
0FA1  0A9E            SII = SII + 1
0FAA  0A9E            IF SII > EII THEN RETURN
0FB8  0A9E            PRINT #1,SII;STI;
0FB3  0A9E            GOTO STEPX
```

```
6  Reagent Jet Printer
   Pattern Printing                                                                    PAGE
                                                                                       09-17
   Offset  Data   Source Line                                                         08:49
                                                          IBM Personal Computer BASIC Compiler V2
    0F07   049E
10  0F07   049E   MENUSUB: 'write old item in yellow, point to and highlight new item
    0F0C   049E          COLOR 14,0:GOSUB DISPMENU
    0F12   049E          MENU% = PMENU% + DIFF%
    0F18   049E          IF MENU% = 10 THEN MENU% = 9
    100C   049E          IF MENU% = 11 THEN MENU% = 9
15  101E   049E          IF MENU% > 15 THEN MENU% = 15
    1030   049E          COLOR 0,7:GOSUB DISPMENU:RETURN
    1046   049E
    1046   049E   INITIALIZE:
    1048   049E          'change to screen 0 and display messages
    1048   049E          SCREEN 0,0,1,1:COLOR 7,0:CLS:LOCATE 10,17:PRINT "Loading selected Reagent and Pattern Data Files";
20  108F   049E          LOCATE 12,33:PRINT "Please Wait..."
    1089   049E
    1089   049E          'initialize notepad on screen 2
    10A9   049E          SCREEN 0,0,2,1:CLS:COLOR 15
    10CC   049E          PRINT"Digital Notepad - - -All information typed here is sent to the printer"
    10D8   049E          NOTELINE% = 3
25  10E2   049E
    10E2   049E          'initialize menu arrays
    10E2   049E          RESTORE ARRDATA
    10E9   049E          FOR II=0 TO 17
    10EF   049E                READ MENU$(II,0),MENU%(II,1)
    111F   049E                READ MENU(II,1),MENU(II,2),MENU(II,3),MENU(II,4)
30  1180   049E          NEXT II
    1193   049E
    1193   049E          'get default reagent file and read values
    1193   049E
    1193   049E          OPEN "REAGDEF.DAT" FOR INPUT AS #1
    11A4   049E          INPUT #1,FILE$
35  11B6   04A2          INPUT #1,REANAME$
    11C8   04A6          CLOSE #1
    11CF   04A6
    11CF   04A6          OPEN FILE$ FOR INPUT AS #1:      'get reagent data
    11E9   04A6          INPUT #1,MENU(0,0):              'frequency
    1200   04A6          INPUT #1,MENU(1,0):              'amplitude
40  1223   04A6          INPUT #1,MENU(2,0):              'strobe delay
    1246   04A6          INPUT #1,MENU(3,0):              'pulse width
    1269   04A6          INPUT #1,MENU(4,0):              'rise time
    128C   04A6          INPUT #1,MENU(5,0):              'fall time
    1231   04A6          CLOSE #1
    1230   04A6
45  1298   04A6          'get default pattern file and read values
    1238   04A6
    1238   04A6          OPEN "PATDEF.DAT" FOR INPUT AS #1
    12E9   04A6          INPUT #1,FILE$
    1208   04A6          INPUT #1,PATNAME$
    12E8   04A6          CLOSE #1
50  12F4   04A6
    12F4   04A6          OPEN FILE$ FOR INPUT AS #1:      'get pattern data
    1205   04A6          INPUT #1,ELMX%
    1317   04A6          INPUT #1,MENU(6,0):              'grid
    132A   04A6          INPUT #1,MENU(7,0):              'repeat count
    133D   04A6          INPUT #1,MENU(8,0):              'x offset
55
```

```
6  Reagent Jet Printer                                                                 PAGE
   Pattern Printing                                                                    09-17
                                                                                       08:49
   Offset  Data    Source Line                      IBM Personal Computer BASIC Compiler V2

   1320   04AA          INPUT #1,MENU(9,0):                  'y offset
   132A   04AA          FOR I% = 0 TO ELMSPC-1
   1331   04AC                  FOR J% = 0 TO 5
   1337   04AC                          INPUT #1,SCRDAT%(I%,J%)
   1388   04AC                  NEXT J%
   13E3   04AC          NEXT I%
   13F8   04AC          CLOSE #1
   1404   04AC
   1404   04AC          'set remaining parameters in menu array
   1404   04AC
   1404   04AC          MENU(12,0) = 1:                      'row 1
   1420   04AC          MENU(13,0) = 1:                      'column 1
   143C   04AC          MENU(14,0) = 0:                      'row spacing
   1458   04AC          MENU(15,0) = 0:                      'column spacing
   1474   04AC
   1474   04AC          'change active displayed screen to screen 0 to draw and display parameters
   1474   04AC
   1474   04AC          SCREEN 0,0,0,1:CLS
   1491   04AC
   1491   04AC          COLOR 13:LOCATE 1,32:PRINT "REAGENT PRINTING";
   14B2   04AC          COLOR 9
   14B9   04AC          FOR I=2 TO 79
   14C3   04AC                  LOCATE 3,I:PRINT CHR$(196);:LOCATE 5,I:PRINT CHR$(205);:LOCATE 18,I:PRINT CHR$(196);
   1523   04B0          NEXT I
   153E   04B0          FOR I=4 TO 17
   1548   04B0                  LOCATE I,1:PRINT CHR$(179);:LOCATE I,28:PRINT CHR$(186);:LOCATE I,54:PRINT CHR$(186);:LOCATE I,8
                 RINT CHR$(179);
   15C8   04B0          NEXT I
   15E6   04B0          RESTORE TABLE
   15E9   04B0          FOR I=1 TO 12
   15F7   04B0                  READ R%,C%,X%:LOCATE R%,C%:PRINT CHR$(X%);
   162A   04B6          NEXT I
   1645   04B6
   1645   04B6          'display 16 menu choices in yellow
   1645   04B6
   1645   04B6          COLOR 14,0
   1651   04B6          FOR MENU% = 0 TO 15
   1657   04B6                  GOSUB DISPMENU
   1658   04B6          NEXT MENU%
   166D   04B6
   1668   04B6          'set for first menu entry and highlight it
   166A   04B6          MENU% = 0:COLOR 0,7
   1680   04B6          GOSUB DISPMENU
   1686   04B6
   1686   04B6          'print three headings and instructions
   1686   04B6          COLOR 10,0
   1692   04B6          LOCATE 4,14.5-LEN(REANAME$)/2:PRINT REANAME$;
   16C1   04B6          LOCATE 4,41-LEN(PATNAME$)/2:PRINT PATNAME$;
   16F0   04B6          LOCATE 4,60:PRINT "PRINT LOCATION";
   170A   04B6
   170A   04B6          COLOR 7:LOCATE 19,20:PRINT "Use ";:COLOR 15:PRINT CHR$(27);CHR$(32);CHR$(26);
   1754   04B6          PRINT CHR$(32);CHR$(24);CHR$(32);CHR$(25);:COLOR 7:PRINT " to position highlighted cursor";
   1793   04B6          LOCATE 20,10:PRINT "Use ";:COLOR 15:PRINT "+";:COLOR 7:PRINT " or ";:COLOR 15:PRINT "-";
   17E9   04B6          COLOR 7:PRINT" to scroll current value up or down";
```

```
Racquet Jet Printer                                                                         PAGE
Pattern Printing                                                                            09-17-
                                                                                            08:49:
Offset  Data   Source Line                                   IBM Personal Computer BASIC Compiler V2.

 17FB   0486          LOCATE 22,3:PRINT "Use ";:COLOR 15:PRINT "P";:COLOR 7:PRINT " to print pattern or ";
 183F   0486          COLOR 15:PRINT "E";:COLOR 7:PRINT " to exit to print menu";
 1867   0486          PRINT " or ";:COLOR 15:PRINT "S";:COLOR 7:PRINT " to use notepad";
 189C   0486
 189C   0486          'set screen to view menu just created and exit
 189C   0486
 189C   0486          SCREEN 0,0,0,0
 18B1   0486          RETURN
 18B5   0486
 18B5   0486   DISPMENU:
 18BA   0486          IF MENU% = 10 OR MENU% = 11 THEN RETURN
 18E2   0486          LOCATE (MENU% MOD 6)*2+7,(INT(MENU%/6)*28+2)-2*INT(MENU%/12)
 1938   0486          PRINT MENU$(MENU%,0)
 1956   0486          LOCATE (MENU% MOD 6)*2+7,MENU(MENU%,4)
 198B   0486          PRINT USING MENU$(MENU%,1);MENU(MENU%,0);
 19BB   0486          RETURN
 19BF   0486   REM $PAGE
```

'Request Ink Printer
Pattern Printing

```
Offset  Data   Source Line

19BF    0486   '************ DATA USED BY THIS MODULE ************
19BF    0486
19BF    0486   ARGDATA:
19C4    0486          DATA "Dot Frequency       Hz","##,###",10000,1,1,16
19C6    0486          DATA "Amplitude           V ","###",150,0,1,19
19C8    0486          DATA "Strobe Delay        uS","##,###.#",15999.5,.5,.5,16
19CA    0486          DATA "Pulse Width          ","###",999,0,1,19
19CC    0486          DATA "Rise Time            ","###",999,0,1,19
19CE    0486          DATA "Fall Time            ","###",999,0,1,19
19D0    0486          DATA "Grid Size          in","#.###",.005,.005,.005,45
19D2    0486          DATA "Repeat Count         ","##",99,0,1,47
19D4    0486          DATA "X Axis Offset      in","#.###",2,0,.005,45
19D6    0486          DATA "Y Axis Offset      in","#.###",2,0,.005,45
19D8    0486          DATA "","",0,0,0,0
19DA    0486          DATA "","",0,0,0,0
19DC    0486          DATA "Row to Print         ","##",99,1,1,74
19DE    0486          DATA "Column to Print      ","##",99,1,1,74
19E0    0486          DATA "Row Spacing        in","#.###",3,0,.005,72
19E2    0486          DATA "Column Spacing     in","#.###",3,0,.005,72
19E4    0486          DATA "","",0,0,0,0
19E6    0486          DATA "","",0,0,0,0
19E8    0486
19EB    0486   TABLE:
19ED    0486          DATA 3,1,218
19EF    0486          DATA 3,28,210
19F1    0486          DATA 3,54,210
19F3    0486          DATA 3,80,191
19F5    0486          DATA 5,1,198
19F7    0486          DATA 5,28,206
19F9    0486          DATA 5,54,206
19FB    0486          DATA 5,80,181
19FD    0486          DATA 18,1,192
19FF    0486          DATA 18,28,208
1A01    0486          DATA 18,54,208
1A03    0486          DATA 18,80,217
1A05    0486
1A05    0486   END SUB
1A0C    0486
1A0C    0486
2049    0486

50426 Bytes Available
44716 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
                1
0030    0000    '$$ $TITLE:'Reagent Jet Printer' $SUBTITLE:'Reagent Filing'
0030    0000    'MODULE  - "REAFILE" File Handling for reagents
0030    0000    '
0030    0000    'AUTHOR  - M. A. Enevold
0030    0000    '
0030    0000    'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
0030    0000    '
0030    0000    'REVISION - 1.1 03-07-86 MAE Added notes and description
0030    0000    '           1.0 02-14-86 MAE Creation of initial code
0030    0000    '
0030    0000    'SYSTEM  - This code can only be compiled by the BASCOM
0030    0000    '          COMPILER, it will not run under the INTERPRETER!!
0030    0000    '
0030    0000    'DESCRIPTION:
0030    0000    '      This module allow file handling for reagents.  When inv
                oked, it displays
0030    0000    '      the current contents of the reagent directory in 4 colu
                mns of 20 entries
0030    0000    '      each.  The reagent which is currently selected for prin
                ting is marked by
0030    0000    '      an asterisk to the left of the reagent name.  After the
                 directory is listed
0030    0000    '      the user is presented with 5 menu choices.  The left an
                d right arrows are
0030    0000    '      used to highlight menu item and the enter key is used
                to invoke action.
0030    0000    '      The menu choices and their actions are:
0030    0000    '
0030    0000    '              DELETE - Remove a reagent file from the directo
                ry
0030    0000    '              COPY -   Copy a reagent file to a new reagent n
                ame, saving the old reagent
0030    0000    '              RENAME - Change the name of the reagent without
                 changing the reagent itself
0030    0000    '              SELECT - Select a reagent for printing
0030    0000    '              EXIT -   Return to the main menu
0030    0000    '
0030    0000    'DATA DICTIONARY
0030    0000    '      TYPE%    Which type of valid key was pushed
0030    0000    '      MENU%    Which menu item is being pointer to (0-4)
0030    0000    '      DIFF%    Distance to move MENU% at left or right arro
                w
0030    0000    '      FLAG%    Error type 0-4
0030    0000    '      POINTER% Position of REANAME$ in directory list
0030    0000    '      REANUM%          Number of reagent names in directory
                 list
0030    0000    '      TEMP%    Storage for integers during reagent copy
0030    0000    '      A$       Misc. input string
0030    0000    '      FUNCT$   Printed at bottom of screen during prompt fo
                r reagent name
0030    0000    '      REANAME$ Reagent name currently being worked on
0030    0000    '      SELNAME$ Reagent name currently selected for printing
0030    0000    '      FILE$    Filename of reagent data file
0030    0000    '      SFILE$   Filename for source reagent data file used d
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

                string copy
 0030   0006    '       OFILES      Filename for destination reagent data file u
                sed during copy
 0030   0006    '       NEWNAMES    New reagent name for COPY and RENAME
 0030   0006    '       TEMPS       Reagent names are held here as the directory
                 is being re-written
 0030   0006    '       NEWFILES    Destination filename used while copying reag
                ent data files
 0030   0006    '       MESSAGES    A message printed at the bottom of the scree
                n
 0030   0006    '       MENUS(4,1) Array of strings containing the short and lo
                ng menu names
 0030   0006    '       ERRMSG      Message printed when any error occurs
 0030   0006    '       ERR         Appended to ERRMSG to indicate nature of er
                ror
 0030   0006    REM $PAGE
```



```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    SUB REAGENT.FILE STATIC
 0047   0006
 0047   0006            GOSUB INITIALIZE
 0048   0006            TYPE% = 0
 0054   0008
 0054   0008            WHILE TYPE% <> 3
 005F   0008                    A$ = ""
 0069   000C                    WHILE A$ = ""
 0078   000C                            A$ = INKEY$
 0082   000C                    WEND
 0085   000C                    IF A$ = CHR$(0) + CHR$(75) THEN TYPE% = 1:
                'left arrow
 00AA   000C                    IF A$ = CHR$(0) + CHR$(77) THEN TYPE% = 2:
                'right arrow
 00CF   000C                    IF A$ = CHR$(13) THEN TYPE% = 3:
                '(cr) to execute selection
 00E9   000C
 00E9   000C                    ON TYPE% GOSUB T1, T2, T3
 00F8   000C            WEND
 00FC   000C
 00FC   000C            EXIT SUB
 0100   000C
 0100   000C    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  4
Reagent Filing                                                         07-09-86
                                                                       15:04:35
Offset  Data    Source Line          IBM Personal Executer BASIC Compiler V2.00

 0100   000C    '********** SUB-ROUTINES FOR THIS MODULE **********
 0100   000C
 0100   000C    T1:             'left arrow
 0103   000C            TYPE1 = 0
 010C   000C            IF MENU% = 0 THEN RETURN
 0118   000E            DIFF1 = -1
 0122   0010            GOSUB MEN.MENU
 0128   0010            RETURN
 012C   0010
 012C   0010    T2:             'right arrow
 0131   0010            TYPE1 = 0
 013B   0010            IF MENU% = 4 THEN RETURN
 0147   0010            DIFF1 = 1
 014E   0010            GOSUB MEN.MENU
 0154   0010            RETURN
 0158   0010
 0158   0010    T3:             '(cr)  (execute selected menu item)
 015D   0010            LOCATE 23,1:PRINT SPACE$(79);
 017A   0010            ON MENU% + 1 GOSUB T3A, T3B, T3C, T3D, T3E
 018F   0010            GOSUB MENU.ON
 0195   0010            RETURN
 0199   0010
 0199   0010    MEN $PAGE
```

```
Offset  Data   Source Line          IBM Personal Computer BASIC Compiler V2.00
 6

 0199   0010   TJA:            'delete reagent
 019E   0010          TYPE% = 0
 01A5   0010          FUNCT$ = "Delete"
 01AF   0018          GOSUB GET.SOURCE
10       01B5   0018          IF LEN(REANAME$) = 0 THEN RETURN
 01C7   001B          IF REANAME$ = SELNAME$ THEN FLAG% = 4:GOSUB SHOW.ERROR:
       RETURN
 01E7   001E          GOSUB SEARCH
 01ED   001E          IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
15       0209   0020
 0209   0020          MESSAGE$ = "Deleting " + REANAME$ + "     Please Wait..
       "
 0220   0024          GOSUB MESSAGE.ON
 0224   0024
20       0224   0024                'rewrite directory deleting REANAME$ as indicat
       ed by POINTER%
 0224   0024          KILL "READIR.OLD"
 022D   0024          NAME "READIR.RJP" AS "READIR.OLD"
 0237   0024          OPEN "READIR.OLD" FOR INPUT AS #1
25       0248   0024          OPEN "READIR.RJP" FOR OUTPUT AS #2
 025A   0024
 025A   0024          INPUT #1, REANUM%
 026C   0026          REANUM% = REANUM% - 1
 0275   0026          WRITE #2,REANUM%
30       0284   0026
 0284   0026          IF REANUM% = 0 THEN GOTO DIR.DONE
 0295   0026          FOR I% = 1 TO REANUM% + 1
 02A4   0028                INPUT #1,REANAME$
 02B4   0028                IF I% <> POINTER% THEN PRINT #2,REANAME$
35       02D3   002A          NEXT I%
 02E3   002A
 02E3   002A    DIR.DONE:
 02EA   002A          CLOSE #1:CLOSE #2
 02F8   002A
40       02F8   002A                'remove data file
 02F8   002A          FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
       "REA.RJP"
 031C   002E          KILL FILE$
 0323   002E
45       0323   002E                'rename remaining data files to maintain linked
       list to directory
 0323   002E          WHILE (REANUM% + 1) > POINTER%
 0333   002E                SFILE$ = RIGHT$(STR$(POINTER%+1),LEN(STR$(POINT
       ER%+1))-1) + "REA.RJP"
50       0359   0032                DFILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER
       %))-1) + "REA.RJP"
 037D   0036                NAME SFILE$ AS DFILE$
 0387   0036                POINTER% = POINTER% + 1
 0390   0036          WEND
55       0393   0036
 0393   0036          GOSUB MESSAGE.OFF
 0399   0036          REANAME$ = SELNAME$
 03A3   0036          GOSUB TJDA
 03A9   0036          GOSUB DISP.DIR
```

```
Reagent Jet Printer                                              PAGE  6
Reagent Filing                                                   07-09-86
                                                                 15:04:35
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 03AF   0036            RETURN
 03B3   0036
 03B3   0036    REM $PAGE
```

```
Reagent Jet Printer                                                    PAGE  7
Reagent Filing                                                         07-09-86
                                                                       15:04:23
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
 6

 0383   003A    T33:    'copy reagent
 0388   003A            TYPE% = 0
 038F   003A            IF REANUM% = 80 THEN FLAG% = 3:GOSUB SHOW.ERROR:RETURN
 0308   003A            FUNCT$ = "Copy"
10  03E5   003A    --      GOSUB GET.SOURCE
 03EB   003A            IF LEN(REANAME$) = 0 THEN RETURN
 03F0   003A            GOSUB SEARCH
 0403   003A            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
 041F   003A
15  041F   003A            GOSUB GET.NEW.NAME
 0425   003A            IF LEN(NEWNAME$) = 0 THEN RETURN
 0437   003A            IF LEN(NEWNAME$) > 15 THEN FLAG% = 2:GOSUB SHOW.ERROR:R
                    ETURN
 0457   003A
20  0457   003A            MESSAGE$ = "Copying " + REANAME$ + " to " + NEWNAME$ +
                     "    Please wait.."
 047C   003A            GOSUB MESSAGE.ON
 0482   003A
 0482   003A                    'add new name at end of directory
25  0482   003A            KILL "READIR.OLD"
 0489   003A            NAME "READIR.RJP" AS "READIR.OLD"
 0493   003A            OPEN "READIR.OLD" FOR INPUT AS #1
 04A4   003A            OPEN "READIR.RJP" FOR OUTPUT AS #2
 04B6   003A
30  04B6   003A            INPUT #1, REANUM%
 04C8   003A            REANUM% = REANUM% + 1
 04D1   003A            WRITE #2,REANUM%
 04E2   003A
 04E2   003A            FOR I% = 1 TO REANUM% - 1
35  04F1   003C                    INPUT #1,TEMP$
 0503   0040                    PRINT #2,TEMP$
 0513   0040            NEXT I%
 0525   0040            PRINT #2,NEWNAME$
 0535   0040
40  0535   0040            CLOSE #1:CLOSE #2
 0543   0040
 0543   0040                    'create copy of data file
 0543   0040            FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
                    "REA.RJP"
45  0567   0040            NEWFILE$ = RIGHT$(STR$(REANUM%),LEN(STR$(REANUM%))-1) +
                     "REA.RJP"
 0588   0044
 0588   0044            OPEN FILE$ FOR INPUT AS #1
 059C   0044            OPEN NEWFILE$ FOR OUTPUT AS #2
50  05AE   0044
 05AE   0044            INPUT #1,TEMP
 05C0   0048            WRITE #2,TEMP:  'frequency
 05D0   0048            INPUT #1,TEMP
 05E2   0048            WRITE #2,TEMP:  'pulse width
55  05F2   0048            INPUT #1,TEMP
 0604   0048            WRITE #2,TEMP:  'strobe delay
 0614   0048            INPUT #1,TEMP
 0626   0048            WRITE #2,TEMP:  'nozzle
 0636   0048
```

Reagent Jet Printer
Reagent Filing

IBM Personal Computer BASIC Compiler V2.00

```
Offset  Data    Source Line
0636    0048            INPUT #1,TEXP$
0648    0048            PRINT #2,TEXP$:         'concentration
065B    0048            INPUT #1,TEXP$
066A    0048            PRINT #2,TEXP$:         'density
067A    0048            INPUT #1,TEXP$
068C    0048            PRINT #2,TEXP$:         'viscosity
069C    0048
069C    0048            CLOSE #1:CLOSE #2
06AA    0048
06AA    0048            GOSUB MESSAGE.OFF
06B0    0048            GOSUB DISP.DIR
06B6    0048            RETURN
06BA    0048
06BA    0048    REM $PAGE
```

```
Offset  Data   Source Line        IBM Personal Computer BASIC Compiler V2.00

 068A   0046   TCC:    'rename reagent
 068F   0047            TYPE% = 0
 06C6   0048            FUNCT$ = "Rename"
 06D0   0049            GOSUB GET.SOURCE
 06D6   004A            IF LEN(REANAME$) = 0 THEN RETURN
 06E8   004B            GOSUB SEARCH
 06EE   004C            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
 070A   004D
 070A   004E            GOSUB GET.NEW.NAME
 0710   004F            IF LEN(NEWNAME$) = 0 THEN RETURN
 0722   0050            IF LEN(NEWNAME$) > 15 THEN FLAG% = 2:GOSUB SHOW.ERROR:R
                      ETURN
 0742   0051            IF NEWNAME$ = REANAME$ THEN RETURN
 0755   0052            MESSAGE$ = "Renaming " + REANAME$ + " to " + NEWNAME$ +
                        "   Please wait.."
 077A   0053            GOSUB MESSAGE.ON
 0780   0054
 0780   0055                    'renaming reagent name in directory
 0780   0056            KILL "READIR.OLD"
 0787   0057            NAME "READIR.RJP" AS "READIR.OLD"
 0791   0058            OPEN "READIR.OLD" FOR INPUT AS #1
 07A2   0059            OPEN "READIR.RJP" FOR OUTPUT AS #2
 07B4   005A
 07B4   005B            INPUT #1, REANUM%
 07C6   005C            WRITE #2,REANUM%
 07D7   005D
 07D7   005E            FOR I% = 1 TO REANUM%
 07E4   005F                    INPUT #1,TEMP$
 07F6   0060                    IF I% <> POINTER% THEN PRINT #2,TEMP$
 0813   0061                    IF I% = POINTER% THEN PRINT #2,NEWNAME$
 0830   0062            NEXT I%
 0842   0063
 0842   0064            CLOSE #1:CLOSE #2
 0850   0065
 0850   0066            GOSUB MESSAGE.OFF
 0856   0067            IF REANAME$ = SELNAME$ THEN REANAME$ = NEWNAME$:GOSUB T
                      DA
 0875   0068            GOSUB DISP.DIR
 087B   0069            RETURN
 087F   006A
 087F   006B    REM $PAGE
```

```
Reagent Jet Printer                                                 PAGE  10
Reagent Filing                                                      07-09-85
                                                                    15:04:35
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0877   004A    TSD:    'select reagent for printing
 0884   004A            TYPEZ = 0
 088B   004A            FUNCT$ = "Select"
 0895   004A            GOSUB GET.SOURCE
 0893   004A            IF LEN(REANAME$) = 0 THEN RETURN
 08A6   004A            IF REANAME$ = SELNAME$ THEN RETURN
 08C3   004A            GOSUB TSDA
 08C6   004A            GOSUB DISP.DIR
 08CC   004A            RETURN
 08D0   004A
 08D0   004A    TSDA:
 08D5   004A            GOSUB SEARCH
 08DB   004A            IF POINTERZ = 0 THEN FLAGZ = 1:GOSUB SHOW.ERROR:RETURN
 08F7   004A
 08F7   004A            MESSAGE$ = "Selecting " + REANAME$ + "     Please Wait.
                ..."
 090E   004A            GOSUB MESSAGE.ON
 0914   004A
 0914   004A                     'change entrys in reagent default file READEF.R
                JP
 0914   004A            OPEN "READEF.RJP" FOR OUTPUT AS #1
 0926   004A            FILE$ = RIGHT$(STR$(POINTERZ),LEN(STR$(POINTERZ))-1) +
                "REA.RJP"
 094A   004A
 094A   004A            PRINT #1,FILE$
 095A   004A            PRINT #1,REANAME$
 096A   004A
 096A   004A            CLOSE #1
 0971   004A            GOSUB MESSAGE.OFF
 0977   004A            RETURN
 097B   004A
 097B   004A    TSE:    'exit reagent filing
 0980   004A            RETURN
 0984   004A
 0984   004A    SEA SPACE
```


BAD ORIGINAL

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
 6

 0984   004A    SEARCH:
 0989   004A            POINTER% = 0
 0990   004A            OPEN "READIR.RJP" FOR INPUT AS #1
 09A1   004A            INPUT #1,REANUM%:'      get number of reagents in direc
10              tory
 09B3   004A            IF REANUM% = 0 THEN CLOSE #1:RETURN
 09C9   004A            TEMP$ = ""
 09D2   004A            WHILE (POINTER% < REANUM%) AND (REANAME$ <> TEMP$)
 09F5   004A                    LINE INPUT #1,TEMP$
15       0A06   004A            POINTER% = POINTER% + 1
         0A11   004A            WEND
         0A14   004A            IF REANAME$ <> TEMP$ THEN POINTER% = 0
         0A2A   004A            CLOSE #1
         0A31   004A            RETURN
20       0A33   004A
         0A33   004A    GET.SOURCE:
         0A3A   004A            LOCATE 25,1:COLOR 15,0:PRINT "Enter Reagent Name to "FU
               NCTS"  ";
         0A4C   004A            LINE INPUT;"",REANAME$
25       0A7A   004A            LOCATE 25,1:PRINT SPACE$(79);
         0A97   004A            RETURN
         0A9B   004A
         0A9B   004A    GET.NEW.NAME:
         0AA0   004A            LOCATE 25,1:COLOR 15,0:PRINT "Enter New Reagent Name ";
30       0AC6   004A            LINE INPUT;"",NEWNAME$
         0AD4   004A            LOCATE 25,1:PRINT SPACE$(79);
         0AF1   004A            RETURN
         0AF5   004A
         0AF5   004A    DISP.DIR:       'display reagent directory in 4 columns of 20 r
35              ows
         0AFA   004A                    'read selected reagent into SELNAME$
         0AFA   004A            OPEN "READEF.RJP" FOR INPUT AS #1
         0B08   004A            INPUT #1,SELNAME$:      'read and discard data file nam
               e
40       0B19   004A            INPUT #1,SELNAME$:      'read and save reagent name
         0B2F   004A            CLOSE #1
         0B36   004A
         0B36   004A            OPEN "READIR.RJP" FOR INPUT AS #1
         0B47   004A            INPUT #1,REANUM%:'      read number of reagents
45       0B59   004A            MESSAGE$ = "Reading Reagent Directory  Please Wait"
         0B63   004A            GOSUB MESSAGE.ON
         0B69   004A            FLAG% = 0
         0B70   004A            TEMP% = REANUM% - 1:IF REANUM% < 80 THEN TEMP% = REANUM
               %
50       0B88   004C            FOR I% = 0 TO TEMP%
         0B97   004E                    LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+1
         0BCA   004E                    PRINT SPACE$(18);
         0BDA   004E            NEXT I%
         0BEC   004E
55       0BEC   004E            FOR I% = 0 TO REANUM% - 1
         0BFA   0050                    INPUT #1,REANAME$
         0C0C   0050                    LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+3
         0C3F   0050                    PRINT REANAME$;
         0C4C   0050                    IF REANAME$ = SELNAME$ THEN LOCATE (I% MOD 20)+
```

```
Offset  Data   Source Line          IBM Personal Computer BASIC Compiler V2.00

                1,(INT(I%/20)*20)+1:PRINT "*";
 0C78   0050            NEXT I%
 0C80   0050            CLOSE #1
 0C87   0050            SYSTEM "RESHAPE.OFF"
 0C8B   0050            RETURN
 0CC1   0050
 0CC1   0050    INITIALIZE:
 0CCA   0050            DIM MENUS(4,1)
 0CC7   0078            MENUS(0,0) = "Delete"
 0CDF   0078            MENUS(0,1) = "Remove a reagent file from the directory"
 0CFA   0078            MENUS(1,0) = "Copy"
 0D15   0078            MENUS(1,1) = "Copy a reagent file to a new reagent base
                        .
 0D2E   0078            MENUS(2,0) = "Rename"
 0D48   0078            MENUS(2,1) = "Rename a reagent file in the directory"
 0D69   0078            MENUS(3,0) = "Select"
 0D84   0078            MENUS(3,1) = "Select a reagent file to be printed"
 0DA0   0078            MENUS(4,0) = "Exit"
 0DB8   0078            MENUS(4,1) = "Return to the main menu"
 0DD7   0078
 0DD7   0078            COLOR 9,0:CLS
 0DEA   0078            LOCATE 21,1
 0DF7   0078            FOR I% = 1 TO 80
 0DFE   0078                    PRINT "D";
 0E08   0078            NEXT I%
 0E18   0078
 0E18   0078            FOR MENU% = 0 TO 4
 0E21   0078                    GOSUB MENU.OFF
 0E27   0078            NEXT MENU%
 0E37   0078
 0E37   0078            GOSUB DISP.DIR
 0E3B   0078            IF FLAG% > 0 THEN GOSUB SHOW.ERROR
 0E4E   0078            MENU% = 4
 0E55   0078            GOSUB MENU.ON
 0E5B   0078
 0E5B   0078            RETURN
 0E5F   0078
 0E5F   0078    MEN.MENU:
 0E64   0078            GOSUB MENU.OFF
 0E6A   0078            MENU% = MENU% + DIFF%
 0E76   0078            GOSUB MENU.ON
 0E7C   0078            RETURN
 0E80   0078
 0E80   0078    MENU.ON:
 0E85   0078            LOCATE 22,(MENU%*10)+18
 0E9C   0078            COLOR 0,7
 0EA8   0078            PRINT MENUS(MENU%,0);
 0EC6   0078            LOCATE 23,40-LEN(MENUS(MENU%,1))/2
 0EFA   0078            COLOR 7,0
 0F06   0078            PRINT MENUS(MENU%,1);
 0F25   0078            RETURN
 0F29   0078
 0F29   0078    MENU.OFF:
 0F2E   0078            LOCATE 22,(MENU%*10)+18
```

```
Reagent Jet Printer                                                    PAGE  13
Reagent Filing                                                         07-09-86
                                                                       15:04:23
Offset  Data   Source Line        IBM Personal Computer BASIC Compiler V2.00
 0F45   0078          COLOR 14,0
 0F51   0078          PRINT MENUS(MENUT,0);
 0F6F   0078          LOCATE 25,40-LEN(MENUS(MENUT,1))/2
 0FA3   0078          PRINT SPACES(LEN(MENUS(MENUT,1)));
 0FCB   0078          RETURN
 0FCC   0078
 0FCC   0078    SHOW.ERROR:
 0FD1   0078          ON FLAG% GOSUB ER1, ER2, ER3, ER4
 0FE2   0078          ERRMSG$ = ERR$ + "    Strike any key.."
 0FF2   0080          LOCATE 24,40-LEN(ERRMSG$)/2
 1014   0080          COLOR 13,0
 1020   0080          PRINT ERRMSG$;
 1029   0080          A$ = ""
 1037   0080          WHILE A$ = ""
 1046   0080                A$ = INKEY$
 1050   0080          WEND
 1053   0080          GOSUB MESSAGE.OFF
 1059   0080          RETURN
 105D   0080
 105D   0080    ER1:
 1062   0080          ERR$ = REANAME$ + " Not Found in the Directory"
 1072   0080          RETURN
 1076   0080
 1076   0080    ER2:
 107B   0080          ERR$ = "Reagent Name is too Long (15 characters max.)"
 1085   0080          RETURN
 1089   0080
 1089   0080    ER3:
 108E   0080          ERR$ = "Directory is Full (60 reagents max.)"
 1098   0080          RETURN
 109C   0080
 109C   0080    ER4:
 10A1   0080          ERR$ = "Cannot Modify SELECTed reagent Name"
 10AB   0080          RETURN
 10AF   0080
 10AF   0080    MESSAGE.ON:
 10B4   0080          LOCATE 24,38 - LEN(MESSAGE$) / 2:COLOR 11,0:PRINT MESSA
                GE$;
 10EF   0080          RETURN
 10F3   0080
 10F3   0080
 10F3   0080    MESSAGE.OFF:
 10FB   0080          LOCATE 24,1:COLOR 15,0:PRINT SPACE$(79);
 1121   0080          RETURN
 1125   0080
 1125   0080    END SUB
 112C   0080
 16C9   0080

 20426 Bytes Available
 45718 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Offset  Data   Source Line          IBM Personal Computer BASIC Compiler V2.00
                1
 0030   0006   REM $TITLE:'Reagent Jet Printer $SUBTITLE:'Pattern Filing'
 0030   0006   'MODULE  - 'PATFILE' File Handling for patterns
 0030   0006   '
 0030   0006   'AUTHOR  - R. A. Enevold
 0030   0006   '
 0030   0006   'COPYRIGHT (C) 1985 ABBOTT LABORATORIES
 0030   0006   '
 0030   0006   'REVISION - 1.0 02-12-86 MAE Creation of initial code
 0030   0006   '
 0030   0006   'SYSTEM  - This code can only be compiled by the BASCOM
 0030   0006   '          COMPILER, it will not run under the INTERPRETER!!
 0030   0006   '
 0030   0006   'DESCRIPTION:
 0030   0006   '       This module allow file handling for patterns.  When inv
                oked, it displays
 0030   0006   '       the current contents of the pattern directory in 4 colu
                mns of 20 entries
 0030   0006   '       each.  The pattern which is currently selected for prin
                ting is marked by
 0030   0006   '       an asterisk to the left of the pattern name.  After the
                 directory is listed
 0030   0006   '       the user is presented with 5 menu choices.  The left an
                d right arrows are
 0030   0006   '       used to highlight menu items and the enter key is used
                to invoke action.
 0030   0006   '       The menu choices and their actions are:
 0030   0006   '
 0030   0006   '               DELETE - Remove a pattern file from the directo
                ry
 0030   0006   '               COPY -   Copy a pattern file to a new pattern n
                ame, saving the old pattern
 0030   0006   '               RENAME - Change the name of the pattern without
                 changing the pattern itself
 0030   0006   '               SELECT - Selct a pattern for printing
 0030   0006   '               EXIT -   Return to the main menu
 0030   0006   '
 0030   0006   'DATA DICTIONARY
 0030   0006   '       TYPE%     Which type of valid key was pushed
 0030   0006   '       MENU%     Which menu item is being pointer to (0-4)
 0030   0006   '       DIFF%     Distance to move MENU% at left or right arro
                w
 0030   0006   '       FLAG%     Error type 0-4
 0030   0006   '       POINTER%  Position of PATNAME$ in directory list
 0030   0006   '       PATNUM%           Number of pattern names in directory
                list
 0030   0006   '       ELNUM%    Number of elements in a pattern file
 0030   0006   '       TEMP%     Storage for integers during pattern copy
 0030   0006   '       I%        Counter used during pattern copy
 0030   0006   '       J%        Counter used during pattern copy
 0030   0006   '       A$        Misc. input string
 0030   0006   '       FUNCT$    Printed at bottom of screen during prompt fo
                r pattern name
 0030   0006   '       PATNAME$  Pattern name currently being worked on
 0030   0006   '       SELNAME$  Pattern name currently selected for printing
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    '       FILE$       Filename of pattern data file
 0030   0006    '       SFILE$      Filename for source pattern data file used d
                uring copy
 0030   0006    '       DFILE$      Filename for destination pattern data file u
                sed during copy
 0030   0006    '       NEWNAME$    New pattern name for COPY and RENAME
 0030   0006    '       TEMP$       Pattern names are held here as the directory
                 is being re-written
 0030   0006    '       NEWFILE$    Destination filename used while copying patt
                ern data files
 0030   0006    '       MESSAGE$    A message printed at the bottom of the scree
                n
 0030   0006    '       MENU$(4,11  Array of strings containing the short and lo
                ng menu names
 0030   0006    '       ERRMSG$     Message printed when any error occurs
 0030   0006    '       ERR$        Appended to ERRMSG$ to indicate nature of er
                ror
 0030   0006    '       TEMP        Storage of real variables while copying patt
                ern data files
 0030   0006    REM $PAGE
```



```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006    SUB PATTERN.FILE STATIC
 0047   0006
 0047   0006            GOSUB INITIALIZE
 004D   0006            TYPE1 = 0
 0054   0008
 0054   0008            WHILE TYPE1 <> 3
 005F   0008                    A$ = ""
 0069   000C                    WHILE A$ = ""
 0078   000C                            A$ = INKEY$
 0082   000C                    WEND
 0085   000C                    IF A$ = CHR$(0) + CHR$(75) THEN TYPE1 = 1:
                'left arrow
 00AA   000C                    IF A$ = CHR$(0) + CHR$(77) THEN TYPE1 = 2:
                'right arrow
 00CF   000C                    IF A$ = CHR$(13) THEN TYPE1 = 3:
                '(cr) to execute selection
 00E9   000C
 00E9   000C                    ON TYPE1 GOSUB T1, T2, T3
 00FB   000C            WEND
 00FC   000C
 00FC   000C            EXIT SUB
 0100   000C
 0100   000C    REM $PAGE
```

Reagent Jet Printer PAGE 4
Pattern Filing 07-09-86
15:11:46

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
 0100  000C  '******** SUB-ROUTINES FOR THIS MODULE ********
 0100  000C
 0100  000C  T1:             'left arrow
 0103  000C          TYPE% = 0
 010C  000C          IF MENU% = 0 THEN RETURN
 0118  000E          DIFF% = -1
 0122  0010          GOSUB NEW.MENU
 0128  0010          RETURN
 012C  0010
 012C  0010  T2:             'right arrow
 0131  0010          TYPE% = 0
 0138  0010          IF MENU% = 4 THEN RETURN
 0147  0010          DIFF% = 1
 014E  0010          GOSUB NEW.MENU
 0154  0010          RETURN
 015B  0010
 015B  0010  T3:             '(cr)  (execute selected menu item)
 015D  0010          LOCATE 25,1:PRINT SPACE$(79);
 017A  0010          ON MENU% + 1 GOSUB T3A, T3B, T3C, T3D, T3E
 018F  0010          GOSUB MENU.ON
 0195  0010          RETURN
 0199  0010
 0199  0010  REM SPACE
```

```
Offset  Data   Source Line          IBM Personal Computer BASIC Compiler V2.00

0199    0010   T3A:                 'delete pattern
019E    0010          TYPE% = 0
01A5    0010          FUNCT$ = "Delete"
01AF    0014          GOSUB GET.SOURCE
01B5    0014          IF LEN(PATNAME$) = 0 THEN RETURN
01C7    0018          IF PATNAME$ = SELNAME$ THEN FLAG% = 4:GOSUB SHOW.ERROR:
              RETURN
01E7    001E          GOSUB SEARCH
01ED    001E          IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
0209    0020
0209    0020          MESSAGE$ = "Deleting " + PATNAME$ + "     Please Wait..
              "
0220    0024          GOSUB MESSAGE.ON
0226    0024
0226    0024                    'rewrite directory deleting PATNAME$ as indicat
              ed by POINTER%
0226    0024          KILL "PATDIR.OLD"
022D    0024          NAME "PATDIR.RJP" AS "PATDIR.OLD"
0237    0024          OPEN "PATDIR.OLD" FOR INPUT AS #1
0248    0024          OPEN "PATDIR.RJP" FOR OUTPUT AS #2
025A    0024
025A    0024          INPUT #1, PATNUM%
026C    0026          PATNUM% = PATNUM% - 1
0275    0026          WRITE #2,PATNUM%
0286    0026
0286    0026          IF PATNUM% = 0 THEN GOTO DIR.DONE
0295    0026          FOR I% = 1 TO PATNUM% + 1
02A4    0028                  INPUT #1,PATNAME$
02B6    0028                  IF I% <> POINTER% THEN PRINT #2,PATNAME$
02D3    002A          NEXT I%
02E3    002A
02E3    002A   DIR.DONE:
02EA    002A          CLOSE #1:CLOSE #2
02F8    002A
02F8    002A                    'remove data file
02F8    002A          FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
              "PAT.RJP"
031C    002E          KILL FILE$
0323    002E
0323    002E                    'rename remaining data files to maintain linked
              list with directory
0323    002E          WHILE (PATNUM% + 1) > POINTER%
0333    002E                  SFILE$ = RIGHT$(STR$(POINTER%+1),LEN(STR$(POINT
              ER%+1))-1) + "PAT.RJP"
0359    0032                  DFILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER
              %))-1) + "PAT.RJP"
037D    0036                  NAME SFILE$ AS DFILE$
0387    0036                  POINTER% = POINTER% + 1
0390    0036          WEND
0393    0036
0393    0036          GOSUB MESSAGE.OFF
0399    0036          PATNAME$ = SELNAME$
03A3    0036          GOSUB T3DA
03A9    0036          GOSUB DISP.DIR
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
03AF  0026          RETURN
03B1  002A
03B3  0C3E    REM SPACE
```

```
Offset  Data    Source Line        IBM Personal Computer BASIC Compiler V2.00

0383    003A    TOP:    'copy pattern
0388    003A            TYPE% = 0
038F    003A            IF PATNUM% = 80 THEN FLAG% = 3:GOSUB SHOW.ERROR:RETURN
0398    003A            FUNCT$ = "Copy"
03A7    003A            GOSUB GET.SOURCE
03B3    003A            IF LEN(PATNAME$) = 0 THEN RETURN
03BF    003A            GOSUB SEARCH
03D3    003A            IF POINTER% = 0 THEN FLAG% = 1:GOSUB SHOW.ERROR:RETURN
03EF    003A
03EF    003A            GOSUB GET.NEW.NAME
0405    003A            IF LEN(NEWNAME$) = 0 THEN RETURN
0417    003A            IF LEN(NEWNAME$) > 15 THEN FLAG% = 2:GOSUB SHOW.ERROR:R
                    ETURN
0437    003A
0437    003A            MESSAGE$ = "Copying " + PATNAME$ + " to " + NEWNAME$ +
                     "   Please wait.."
0470    003A            GOSUB MESSAGE.GN
0482    003A
0482    003A                    'add NEWNAME$ at end of directory
0482    003A            KILL "PATDIR.OLD"
0489    003A            NAME "PATDIR.DAT" AS "PATDIR.OLD"
0493    003A            OPEN "PATDIR.OLD" FOR INPUT AS #1
04A4    003A            OPEN "PATDIR.DAT" FOR OUTPUT AS #2
04B6    003A
04B6    003A            INPUT #1, PATNUM%
04C8    003A            PATNUM% = PATNUM% + 1
04D1    003A            WRITE #2,PATNUM%
04E2    003A
04E2    003A            FOR I% = 1 TO PATNUM% - 1
04F1    003C                    INPUT #1,TEMP$
0503    0040                    PRINT #2,TEMP$
0513    0040            NEXT I%
0525    0040            PRINT #2,NEWNAME$
0535    0040
0535    0040            CLOSE #1:CLOSE #2
0543    0040
0543    0040                    'create copy of pattern data file
0543    0040            FILE$ = RIGHT$(STR$(POINTER%),LEN(STR$(POINTER%))-1) +
                    "PAT.DAT"
0547    0040            NEWFILE$ = RIGHT$(STR$(PATNUM%),LEN(STR$(PATNUM%))-1) +
                     "PAT.DAT"
0588    0044
0588    0044            OPEN FILE$ FOR INPUT AS #1
059C    0044            OPEN NEWFILE$ FOR OUTPUT AS #2
05AE    0044
05AE    0044            INPUT #1,ELNUM%
05C9    0046            WRITE #2,ELNUM%
05D1    0046
05D1    0046            FOR I% = 1 TO 4
05DB    0046                    INPUT #1,TEMP
05EA    004A                    WRITE #2,TEMP
05FA    004A            NEXT I%
060A    004A
060A    004A            FOR I% = 1 TO ELNUM%
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0842   0052            RETURN
 0846   0052
 0846   0052    REM $PAGE
```



```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0846   0052    TJD:            'select pattern for printing
 0848   0052            TYPE1 = 0
 0852   0052            FUNCT$ = "Select"
 085C   0052            GOSUB GET.SOURCE
 0862   0052            IF LEN(PATNAME$) = 0 THEN RETURN
 0874   0052            IF PATNAME$ = SELNAME$ THEN RETURN
 0887   0052            GOSUB TJDA
 088D   0052            GOSUB DISP.DIR
 0893   0052            RETURN
 0897   0052
 0897   0052    TJDA:
 089C   0052            GOSUB SEARCH
 08A2   0052            IF POINTER1 = 0 THEN FLAG1 = 1:GOSUB SHOW.ERROR:RETURN
 08BE   0052
 08BE   0052            MESSAGE$ = "Selecting " + PATNAME$ + "     Please Wait.
                ..."
 08D5   0052            GOSUB MESSAGE.ON
 08DB   0052
 08DB   0052                    'change entrys in pattern default file PATDEF.R
                JP
 08DB   0052            OPEN "PATDEF.RJP" FOR OUTPUT AS #1
 08ED   0052            FILE$ = RIGHT$(STR$(POINTER1),LEN(STR$(POINTER1))-1) +
                "PAT.RJP"
 0911   0052
 0911   0052            PRINT #1,FILE$
 0921   0052            PRINT #1,PATNAME$
 0931   0052
 0931   0052            CLOSE #1
 0938   0052            GOSUB MESSAGE.OFF
 093E   0052            RETURN
 0942   0052
 0942   0052    TJE:    'exit pattern filing
 0947   0052            RETURN
 0948   0052
 0948   0052    REM $PAGE
```

```
Offset  Data   Source Line          IBM Personal Computer BASIC Compiler V2.00
 5
 0948   0052   SEARCH:
 0950   0052          POINTER% = 0
 0957   0052          OPEN "PATDIR.DAT" FOR INPUT AS #1
 0968   0052          INPUT #1,PATNUM%:'      get number of patterns in direc
10                  tory
 097A   0052          IF PATNUM% = 0 THEN CLOSE #1:RETURN
 0990   0052          TEMP$ = ""
 099A   0052          WHILE (POINTER% < PATNUM%) AND (PATNAME$ <> TEMP$)
 09C2   0052                LINE INPUT #1,TEMP$
16 09CF   0052                POINTER% = POINTER% + 1
 09D8   0052          WEND
 09DB   0052          IF PATNAME$ <> TEMP$ THEN POINTER% = 0
 09F1   0052          CLOSE #1
 09F8   0052          RETURN
20 09FC   0052
 09FC   0052   GET.SOURCE:
 0A01   0052          LOCATE 25,1:COLOR 15,0:PRINT "Enter Pattern Name to "FU
                    NCT$"  ";
 0A33   0052          LINE INPUT:"",PATNAME$
25 0A41   0052          LOCATE 25,1:PRINT SPACE$(79);
 0A5E   0052          RETURN
 0A62   0052
 0A62   0052   GET.NEW.NAME:
 0A67   0052          LOCATE 25,1:COLOR 15,0:PRINT "Enter New Pattern Name ";
30 0A8D   0052          LINE INPUT:"",NEWNAME$
 0A9B   0052          LOCATE 25,1:PRINT SPACE$(79);
 0AB8   0052          RETURN
 0ABC   0052
 0ABC   0052   DISP.DIR:       'display directory in 4 columns, 20 rows
35 0AC1   0052                'read default pattern name into SELNAME$
 0AC1   0052          OPEN "PATDEF.DAT" FOR INPUT AS #1
 0AD2   0052          INPUT #1,SELNAME$:      'discard data file name
 0AE4   0052          INPUT #1,SELNAME$
 0AF6   0052          CLOSE #1
40 0AFD   0052
 0AFD   0052          OPEN "PATDIR.DAT" FOR INPUT AS #1
 0B0E   0052          INPUT #1,PATNUM%:'      read number of patterns
 0B20   0052
 0B20   0052          MESSAGE$ = "Reading Pattern Directory  Please Wait"
45 0B2A   0052          GOSUB MESSAGE.SB
 0B30   0052          FLAG% = 0
 0B37   0052          TEMP1% = PATNUM% - 1:IF PATNUM% < 80 THEN TEMP1% = PATNUM
                    %
 0B52   0052          FOR I% = 0 TO TEMP1%
50 0B5E   0054                LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+1
 0B91   0054                PRINT SPACE$(18);
 0BA1   0054          NEXT I%
 0BB3   0054
 0BB3   0054          FOR I% = 0 TO PATNUM% - 1
55 0BC1   0056                INPUT #1,PATNAME$
 0BD3   0056                LOCATE (I% MOD 20)+1,(INT(I%/20)*20)+3
 0C06   0056                PRINT PATNAME$;
 0C13   0056                IF PATNAME$ = SELNAME$ THEN LOCATE (I% MOD 20)+
                    1,(INT(I%/20)*20)+1:PRINT "*";
```

```
Offset  Byte   Source Line
0C42    0056           NEXT I%
0C77    0056           CLOSE #1
0C7E    0056           GOSUB MESSAGE.OFF
0C84    0056           RETURN
0C86    0056
0C88    0056   INITIALIZE:
0C8D    0056           DIM MENUS(4,1)
0C8E    007E           MENUS(0,0) = "Delete"
0CA6    007E           MENUS(0,1) = "Remove a pattern file from the directory"
0CC1    007E           MENUS(1,0) = "Copy"
0CDC    007E           MENUS(1,1) = "Copy a pattern file to a new pattern name
                       "
0CF5    007E           MENUS(2,0) = "Rename"
0D12    007E           MENUS(2,1) = "Rename a pattern file in the directory"
0D30    007E           MENUS(3,0) = "Select" _
0D48    007E           MENUS(3,1) = "Select a pattern file to be printed"
0D67    007E           MENUS(4,0) = "Exit"
0D82    007E           MENUS(4,1) = "Return to the main menu"
0D9E    007E
0D9E    007E           COLOR 9,0:CLS
0DB1    007E           LOCATE 21,1
0DBE    007E           FOR I% = 1 TO 80
0DC5    007E                   PRINT "B";
0DD2    007E           NEXT I%
0DE2    007E
0DE2    007E           FOR MENUI = 0 TO 4
0DE8    007E                   GOSUB MENU.OFF
0DEE    007E           NEXT MENUI
0DFE    007E
0DFE    007E           GOSUB DISP.DIR
0E04    007E           IF FLAG% > 0 THEN GOSUB SHOW.ERROR
0E15    007E           MENUI = 4
0E1C    007E           GOSUB MENU.ON
0E22    007E
0E22    007E           RETURN
0E26    007E
0E26    007E   NEW.MENU:
0E2B    007E           GOSUB MENU.OFF
0E31    007E           MENUI = MENUI + DIFF%
0E3B    007E           GOSUB MENU.ON
0E43    007E           RETURN
0E47    007E
0E47    007E   MENU.ON:
0E4C    007E           LOCATE 22,(MENUI*10)+18
0E63    007E           COLOR 0,7
0E6F    007E           PRINT MENUS(MENUI,0);
0E8D    007E           LOCATE 25,40-LEN(MENUS(MENUI,1))/2
0EC1    007E           COLOR 7,0
0EC9    007E           PRINT MENUS(MENUI,1);
0EEC    007E           RETURN
0EF4    007E
0EF0    007E   MENU.OFF:
0EF5    007E           LOCATE 22,(MENUI*10)+18
0F0C    007E           COLOR 14,0
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0F18   007E            PRINT MENU$(MENUT,0);
 0F36   007E            LOCATE 25,40-LEN(MENU$(MENUT,1))/2
 0F6A   007E            PRINT SPACE$(LEN(MENU$(MENUT,1)));
 0F8F   007E            RETURN
 0F93   007E
 0F93   007E    SHOW.ERROR:
 0F98   007E            ON FLAG% GOSUB ER1, ER2, ER3, ER4
 0FA9   007E            ERRMSG$ = ERR$ + "     Strike any key.."
 0FD9   0086            LOCATE 24,40-LEN(ERRMSG$)/2
 0FDB   0086            COLOR 15,0
 0FE7   0086            PRINT ERRMSG$;
 0FF4   0086            A$ = ""
 0FFE   0086            WHILE A$ = ""
 100B   0086                  A$ = INKEY$
 1017   0086            WEND
 101A   0086            GOSUB MESSAGE.OFF
 1020   0086            RETURN
 1024   0086
 1024   0086    ER1:
 1029   0086            ERR$ = PATHNAME$ + " Not Found in the Directory"
 1039   0086            RETURN
 103D   0086
 103D   0086    ER2:
 1042   0086            ERR$ = "Pattern Name is too Long (15 characters max.)"
 104C   0086            RETURN
 1050   0086
 1050   0086    ER3:
 1055   0086            ERR$ = "Directory is Full (80 patterns max.)"
 105F   0086            RETURN
 1063   0086
 1063   0086    ER4:
 1068   0086            ERR$ = "Cannot Modify SELECTd pattern Name"
 1072   0086            RETURN
 1076   0086
 1076   0086    MESSAGE.ON:
 1078   0086            LOCATE 24,38 - LEN(MESSAGE$) / 2:COLOR 11,0:PRINT MESSA
                GE$;
 1086   0086            RETURN
 108A   0086
 108A   0086
 108A   0086    MESSAGE.OFF:
 108F   0086            LOCATE 24,1:COLOR 15,0:PRINT SPACE$(79);
 10EB   0086            RETURN
 10EC   0086
 10EC   0086    END SUB
 10F3   0086
 1688   0086

50426 Bytes Available
45670 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

```
Reagent Jet Printer                                                    PAGE  1
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00
 5
 0030   0006    REM $TITLE:'Reagent Jet Printer' $SUBTITLE:'Main Line Code'
 0030   0006
 0030   0006    'MODULE   - "MAIN"
 0030   0006
10       0030   0006    'AUTHOR   - M. A. Enevold
 0030   0006
 0030   0006    'COPYRIGHT (C) 1986 ABBOTT LABORATORIES
 0030   0006
 0030   0006    'REVISION - 1.1 02-19-86 MAE Add notes and revise TYPE% resetin
15       g
 0030   0006    '         - 1.0 02-14-86 MAE Creation of initial code
 0030   0006
 0030   0006    'SYSTEM   - This code can only be compiled by the BASCOM
 0030   0006    '           COMPILER, it will not run under the INTERPRETER!!
20       0030   0006
 0030   0006    'DESCRIPTION
 0030   0006    '       This is the main controlling module for the Reagent Jet
          Printer.
 0030   0006    '       It displays a menu in table form that allows 6 function
25       s to be
 0030   0006    '       selected.  PATTERN DEFINITION allows the user to define
          patterns
 0030   0006    '       to be printed.  PATTERN FILING lets the user delete, co
          py, rename
30       0030   0006    '       and select patterns for printing.  REAGENT CALIBRATION
          permits setting
 0030   0006    '       of operation parameters for different reagents.  REAGEN
          T FILING is
 0030   0006    '       the same as pattern filing.  PRINTING PRINT prints the
35       selected
 0030   0006    '       pattern with the selected reagent.  SYSTEM EXIT TO DOS
          ends the session.
 0030   0006    '       Using up and down arrow keys let the user move through
          the menu and
40       0030   0006    '       the Enter (cr) key activates the selection.
 0030   0006
 0030   0006    'DATA DICTIONARY
 0030   0006    '       MENU%           This value represents the current menu
          item (0-5)
45       0030   0006    '       MENU$(5,1)      String array for displaying menu items.
            6 rows by 2 columns
 0030   0006    '                       Each row corresponds to a menu item (0-
          5)
 0030   0006    '                       First column is short menu name in high
50       lighted area
 0030   0006    '                       Second column is long description displ
          ayed at menu bottom
 0030   0006    '       ARROW%(5)       This array stores to row in which the s
          hort menu name will be displayed
55       0030   0006    '       DIFF%           This value is used it change MENU% in r
          esponse to arrow keys
 0030   0006    '       TYPE%           This value is set based on which valid
          key is pressed
 0030   0006    '                       0 = No valid key.  1 = Up Arrow.  2 = D
```

```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

                een Arrow.  3 = (cr).
 0030   0006    '       TEMP%        Used to store MENU% while screen is ref
                reshed
 0030   0006    '       A$           Used to store single input keystrokes
 0030   0006    '       C$           Used to store special graphics characte
                rs used in drawing the menu table
 0030   0006    '       I%           Counter used to refresh display
 0030   0006    '       R%           Row in which special graphics character
                 is displayed
 0030   0006    '       C%           Column in which special graphics charac
                ter is displayed
 0030   0006    REM $PAGE
```



```
Offset  Data    Source Line          IBM Personal Computer BASIC Compiler V2.00

 0030   0006
 0030   0006    'Main-line code for RJP Reagent Jet Printer
 0030   0006
 0030   0006    MAIN.LINE.CODE:
 0030   0006
 0030   0006            GOSUB INITIALIZE
 0043   0006
 0045   0008            WHILE TYPE% () 3
 0056   0008
 0056   0008                    TYPE% = 0
 005D   0008                    A$ = ""
 0067   000C                    WHILE A$ = ""
 0076   000C                            A$ = INKEY$
 0080   000C                    WEND
 0083   000C
 0083   000C                    IF A$ = CHR$(0) + CHR$(72) THEN TYPE% = 1:'
                up arrow
 0098   000C                    IF A$ = CHR$(0) + CHR$(80) THEN TYPE% = 2:'
                down arrow
 00CB   000C                    IF A$ = CHR$(13) THEN TYPE% = 3:'
                (cr) execute command
 00E7   000C
 00E7   000C                    ON TYPE% GOSUB T1, T2, T3
 00F6   000C
 00F6   000C            WEND
 00F8   000C
 00FA   000C            CLS
 0101   000C            COLOR 7,0,0
 0112   000C            SYSTEM
 0116   000C
 0116   000C    REM $PAGE
```

```
Reagent Dat Printer                                                    PAGE  4
Main Line Code                                                         07-09-86
                                                                       15:27:04
Offset  Data    Source Line        IBM Personal Computer BASIC Compiler V2.00

 0116   000C    '******** SUB-ROUTINES FOR MAIN PROGRAM
 0116   000C    T1:     'up arrow
 0118   000C            IF MENU% = 0 THEN RETURN
 012A   000E            DIFF% = -1
 0131   0010            GOSUB KEY.MENU
 0137   0010            RETURN
 013B   0010
 013B   0010    T2:     'down arrow
 0140   0010            IF MENU% = 5 THEN RETURN
 014F   0010            DIFF% = 1
 0156   0010            GOSUB KEY.MENU
 015C   0010            RETURN
 0160   0010
 0160   0010    T3:
 0163   0010            ON MENU% + 1 GOSUB T31, T32, T33, T34, T35, T36
 017C   0010            IF MENU% < 5 THEN TYPE% = 0:'  reset TYPE% so progra
                    m won't end
 018E   0010            SCREEN 0,0,3,3
 01A5   0010            RETURN
 01A9   0010
 01A9   0010    T31:    'pattern definition
 01AE   0010            CALL PATENTRY:          'in module PATENT
 01BA   0010            GOSUB REFRESH
 01C0   0010            RETURN
 01C4   0010
 01C4   0010    T32:    'pattern filing
 01C9   0010            SCREEN 0,0,0,0:CLS
 01E3   0010            CALL PATTERN.FILE:      'in module PATFILE
 01F1   0010            RETURN
 01F5   0010
 01F5   0010    T33:    'reagent calibration
 01FA   0010            CALL REAGENT.CALIBRATE: 'in module REACAL
 0206   0010            RETURN
 020A   0010
 020A   0010    T34:    'reagent filing menu
 020F   0010            SCREEN 0,0,0,0:CLS
 0228   0010            CALL REAGENT.FILE:      'in module REAFILE
 0237   0010            RETURN
 023B   0010
 023B   0010    T35:    'print pattern
 0240   0010            CALL PATPRINT:          'in module PATPRINT
 024C   0010            RETURN
 0250   0010
 0250   0010    T36:    'exit system, don't reset TYPE%
 0255   0010            RETURN
 0259   0010
 0259   0010    REM $PAGE
```

```
Reagent Jet Printer
Main Line Code                                                         PAGE  5
                                                                       07-09-86
 Offset  Data    Source Line                                           15:27:04
                                    IBM Personal Computer BASIC Compiler V2.00

 0259    0010    NEW.MENU:
 025E    0010            GOSUB MENU.OFF
 0264    0010            MENU% = MENU% + DIFF%
 0270    0010            GOSUB MENU.ON
 0276    0010            RETURN
 027A    0010
 027A    0010    INITIALIZE:
 027F    0010            CALL PCI.INIT
 0287    0010
 028B    0010    '       define and initialize arrays
 028B    0010            DIM MROW%(5)
 028C    001C            MROW%(0) = 4
 029E    001C            MROW%(1) = 6
 02B1    001C            MROW%(2) = 10
 02C4    001C            MROW%(3) = 12
 02D7    001C            MROW%(4) = 16
 02EA    001C            MROW%(5) = 20
 02FD    001C
 02FD    001C            DIM MENUS$(5,1)
 02FE    004C            RESTORE MENU.STRING.DATA
 0305    004C            FOR I% = 0 TO 5
 030B    004C                    READ MENUS$(I%,0),MENUS$(I%,1)
 033B    004E            NEXT I%
 034B    004E
 034B    004E    '       set initial values into variables
 034B    004E            TYPE% = 0
 0352    004E            MENU% = 0
 0359    004E
 0359    004E    REFRESH:'redraw screen and highlight current menu selection
 035E    004E
 035E    004E            SCREEN 0,0,0,0:CLS:COLOR 7,0,0
 038B    004E            LOCATE 10,32:PRINT "Loading Menu....."
 03A5    004E            SCREEN 0,0,3,0:CLS
 03C2    004E
 03C2    004E
 03C2    004E            COLOR 13,0
 03CE    004E            LOCATE 1.31
 03DB    004E            PRINT "REAGENT JET PRINTER";
 03E7    004E            COLOR 10,0
 03F4    004E            LOCATE 5,26
 0401    004E            PRINT "PATTERN"
 040E    004E            LOCATE.11,26
 041B    004E            PRINT "REAGENT"
 0428    004E            LOCATE 16.26
 0435    004E            PRINT "PRINTING"
 0442    004E            LOCATE 20,27
 044F    004E            PRINT "SYSTEM"
 045C    004E
 045C    004E    '       draw the menu table in special graphics characters
 045C    004E            COLOR 9,0
 0468    004E            FOR I% = 18 TO 62
 046F    004E                    LOCATE 2,I%:PRINT "D";
 048A    004E                    LOCATE 8,I%:PRINT "D";
 04A5    004E                    LOCATE 14,I%:PRINT "D";
```

```
04C0  004E                 LOCATE 18,I%:PRINT "D";
04DB  004E                 LOCATE 22,I%:PRINT "D";
04F6  004E                 LOCATE 24,I%:PRINT "D";
0511  004E          NEXT I%
0524  004E          FOR I% = 3 TO 23
052B  004E                 LOCATE I%,17:PRINT "J";
0546  004E                 LOCATE I%,64:PRINT "J";
0561  004E          NEXT I%
0571  004E          RESTORE TABLE
0578  004E          FOR I% = 1 TO 12
057F  004E                 READ R%,C%,C$
0592  0056                 LOCATE R%,C%:PRINT C$;
05AE  0056          NEXT I%
05BE  0056
05BE  0056     '    print the instructions
05BE  0056          COLOR 7,0
05CA  0056          LOCATE 25,6
05D7  0056          PRINT "Use   or   to highlight menu items.  Use     to
activate selection.";
05E4  0056
05E4  0056          COLOR 15,0
";
060A  0056          LOCATE 25,15:PRINT "";
0624  0056          LOCATE 25,47:PRINT "PT";
063E  0056
063E  0056     '    display the 6 menu choices
063E  0056          TEMP% = MENU%
0645  005B          FOR MENU% = 0 TO 5
064B  005B                 GOSUB MENU.OFF
0651  005B          NEXT MENU%
0661  005B          MENU% = TEMP%
0668  005B
0668  005B     '    highlight the currently active menu item
0668  005B          GOSUB MENU.ON
066E  005B
066E  005B          SCREEN 0,0,3,3
0685  005B          RETURN
0689  005B
0689  005B MENU.ON:'highlight the menu MENU% and display its long descript
ion
068E  005B          COLOR 0,7
069A  005B          LOCATE RROW%(MENU%),32-LEN(MENU$(MENU%,0))/2
06DA  005B          PRINT MENU$(MENU%,0);
06F8  005B          COLOR 7,0
0704  005B          LOCATE 23,40.5-LEN(MENU$(MENU%,1))/2
073B  005B          PRINT MENU$(MENU%,1);
0757  005B          RETURN
075B  005B
075B  005B MENU.OFF:'un-highlight menu MENU% and erase long description
0760  005B          COLOR 14,0
076C  005B          LOCATE RROW%(MENU%),32-LEN(MENU$(MENU%,0))/2
07AC  005B          PRINT MENU$(MENU%,0);
07CA  005B          COLOR 7,0
07D6  005B          LOCATE 23,40.5-LEN(MENU$(MENU%,1))/2
```

Offset Data Source Line IBM Personal Computer BASIC Compiler V2.00

```
 060A  0053          PRINT SPACE$(LEN(MENU$(MENUX,1)));
 062F  C3C8          RETURN
 0833  0058
 0833  0058    REM $PAGE
```

```
Reagent Jet Printer                                              PAGE  8
Main Line Code                                                   07-09-86
                                                                 15:27:04
Offset  Data   Source Line        IBM Personal Computer BASIC Compiler V2.00

0833    0058   '******** DATA FIELDS USED BY THE MAIN PROGRAM ********
0833    0058
0833    0058   MENU.STRINGS.DATA:      'first entry is menu name, second is lo
                ng description
0838    0058
0838    0058           DATA "DEFINITION", "Create and Modify Patterns"
083A    0058           DATA "FILING",     "Delete, Copy, Rename, and Select Pa
                tterns"
083C    0058           DATA "CALIBRATION","Calibrate and Modify Reagent Profil
                es"
083E    0058           DATA "FILING",     "Delete, Copy, Rename, and Select Re
                agents"
0840    0058           DATA "PRINT",      "Print Selected Pattern with Selecte
                d Reagent"
0842    0058           DATA "EXIT TO DOS","Leave Program and Return to DOS"
0844    0058
0844    0058   TABLE:  'first entry is row, second is column, third is special
                 graphics character
0849    0058
0849    0058           DATA 2,17,"Z"
084B    0058           DATA 2,64,"?"
084D    0058           DATA 8,17,"C"
084F    0058           DATA 8,64,"4"
0851    0058           DATA 14,17,"C"
0853    0058           DATA 14,64,"4"
0855    0058           DATA 18,17,"C"
0857    0058           DATA 18,64,"4"
0859    0058           DATA 22,17,"C"
085B    0058           DATA 22,64,"4"
085D    0058           DATA 24,17,"8"
085F    0058           DATA 24,64,"7"
0861    0058
0861    0058           END
0865    0058
0842    0058

50426 Bytes Available
47680 Bytes Free

    0 Warning Error(s)
    0 Severe  Error(s)
```

Claims

1. A dispensing system for use in diagnostic instruments for precise metering of a desired diagnostic fluid, the system comprising:

a jetting chamber defining a volume and comprising a first and second aperture, the first aperture adapted to receive diagnostic fluid, the second aperture defining an orifice;

a transducer in mechanical communication with the jetting chamber, the transducer operative to alternately expand and de-expand the volume of the jetting chamber in response to a selected electrical pulse and

thereby cause the jetting chamber to emit a substantially uniformly sized droplet of diagnostic fluid through the orifice; and

means for generating a number of electrical pulses sufficient to cause a desired quantity of the diagnostic fluid to be dispensed.

2. The invention of Claim 1 wherein the system further comprises:

at least one additional jetting chamber in fluid communication with an additional diagnostic fluid;

at least one additional transducer in mechanical communication with the additional jetting chamber;

at least one additional means for applying an electrical pulse to the additional transducer;

means for generating respective numbers of electrical pulses sufficient to cause precise quantities of the diagnostic fluids to be dispensed in a desired volumetric ratio; and

a receptacle adapted for and positioned to receive the fluids.

3. The invention of Claim 1 wherein the system further comprises:

means for directing at least one of (1) the receptacle and (2) the emitted diagnostic fluid and the emitted addi-tional diagnostic fluid such that desired quantities of the fluids are dispensed into the receptacle in a predefined dispensing order.

4. The invention of Claim 1 wherein one of the diagnostic fluids comprises serum and wherein the jetting chambers cooperate such that the other diagnostic fluid is emitted in a manner to contact and mix with the serum.

5. The invention of Claim 1 wherein the jetting chamber comprises a cylindrical tube and wherein the trans-ducer is mounted concentrically about the cylindrical tube.

6. The invention of Claim 1 wherein the jetting chamber is conically shaped.

7. The invention of Claim 1 wherein the jetting chamber comprises at least one chamber wall which is integrally formed with the transducer.

8. The invention of Claim 1 wherein the transducer is one of (1) a piezo-electric transducer; (2) a magneto-strictive transducer; (3) an electro-strictive transducer; and (4) an electro-mechanical transducer.

9. The invention of Claim 1 wherein the jetting chamber is conically shaped; and wherein the transducer is disc shaped and forms the base of the conically shaped jetting chamber.

10. The invention of Claim 1 wherein the orifice comprises an end face and the end face is coated with a hydrophobic polymer.

11. The invention of Claim 1 wherein the transducer is cylindrically shaped and comprises a first electrode located on the inner wall of the cylinder and wraps around one end of the cylinder and wherein a second electrode is located substantially on the outer wall of the cylinder and is electrically isolated from the first electrode.

12. The invention of Claim 1 wherein the means for generating produces an electrical pulse of selected rise and fall time constants and of selected duration, voltage and polarity.

13. The invention of Claim 1 wherein the means for generating the electrical pulse comprises means for scaling the voltage of the pulse in response to a selectable digital value.

14. The invention of Claim 1 wherein the apparatus further comprises means for directing the emitted diagnostic fluid along a desired path.

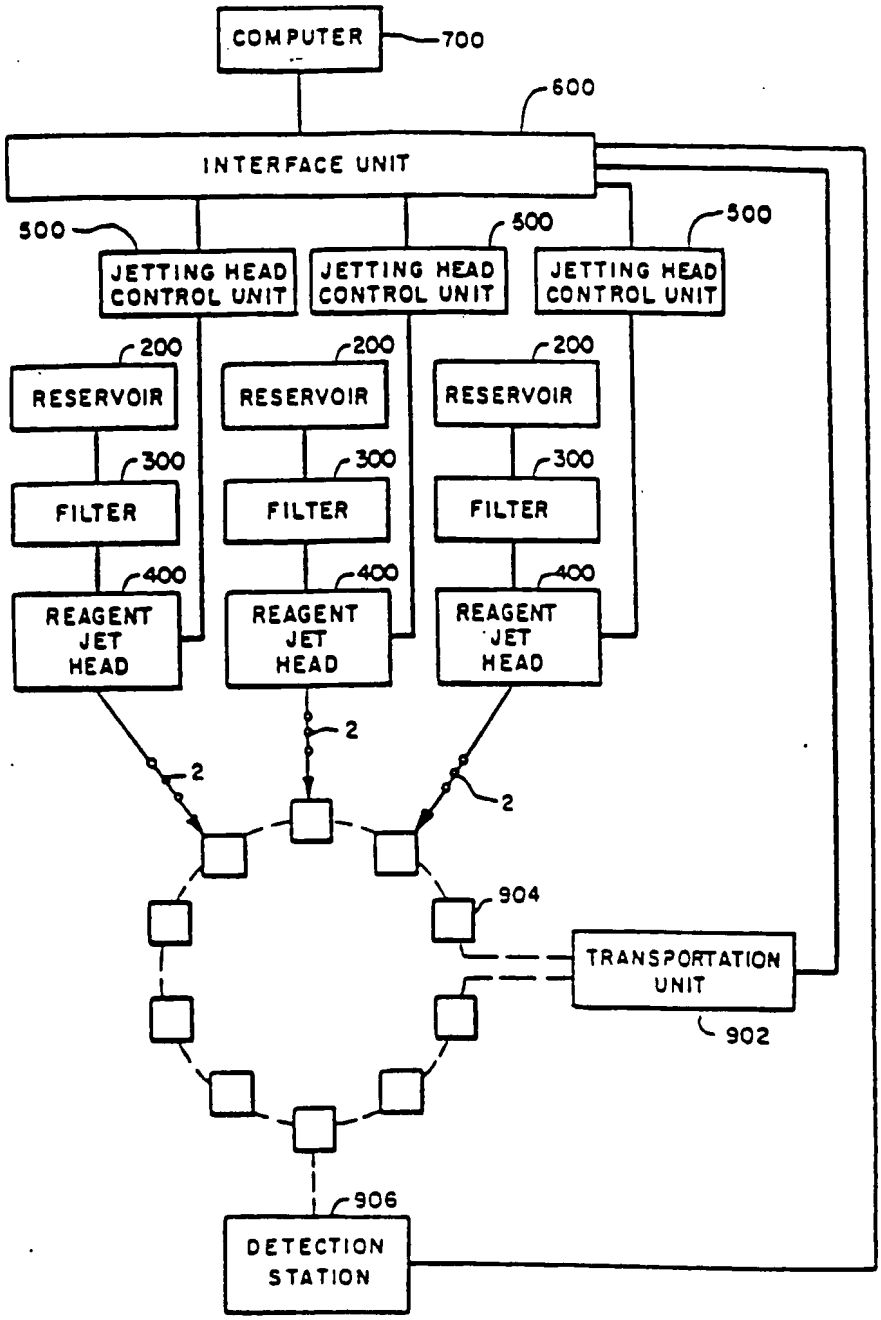
15. A method of dispensing precise quantities of diagnostic fluids comprising the steps of:

(a) generating an electrical pulse of predefined characteristics;

(b) reducing the volume of a chamber containing the diagnostic fluid by electro-mechanical means in response to the electrical pulse such that a droplet of fluid of known volume is propelled through an orifice in the chamber; and

(c) repeating steps (a) and (b) until a desired quantity of the diagnostic fluid has been dispensed

FIG. 1


COMPUTER
700
600
INTERFACE UNIT
500
JETTING HEAD CONTROL UNIT
500
JETTING HEAD CONTROL UNIT
500
JETTING HEAD CONTROL UNIT
200
RESERVOIR
200
RESERVOIR
200
RESERVOIR
300
FILTER
300
FILTER
300
FILTER
400
REAGENT JET HEAD
400
REAGENT JET HEAD
400
REAGENT JET HEAD
2
2
2
904
TRANSPORTATION UNIT
902
906
DETECTION STATION

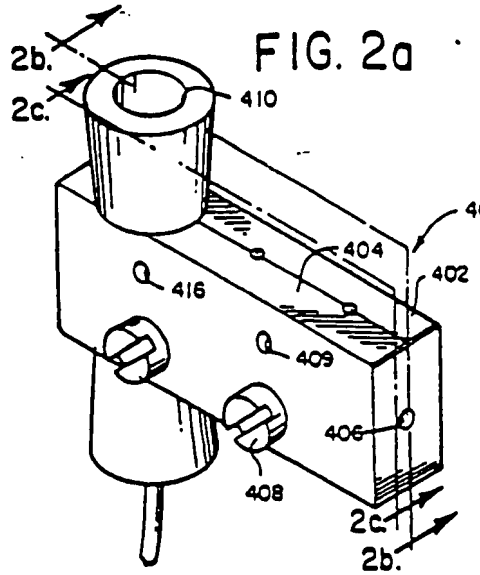


FIG. 2a

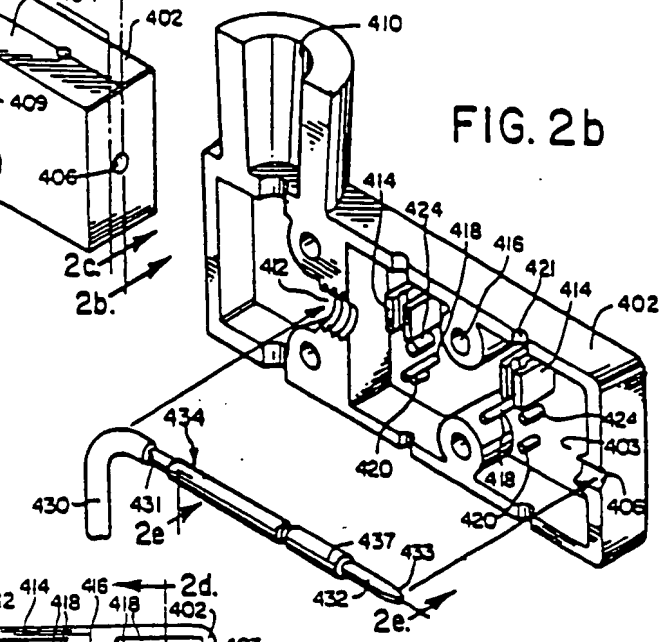


FIG. 2b

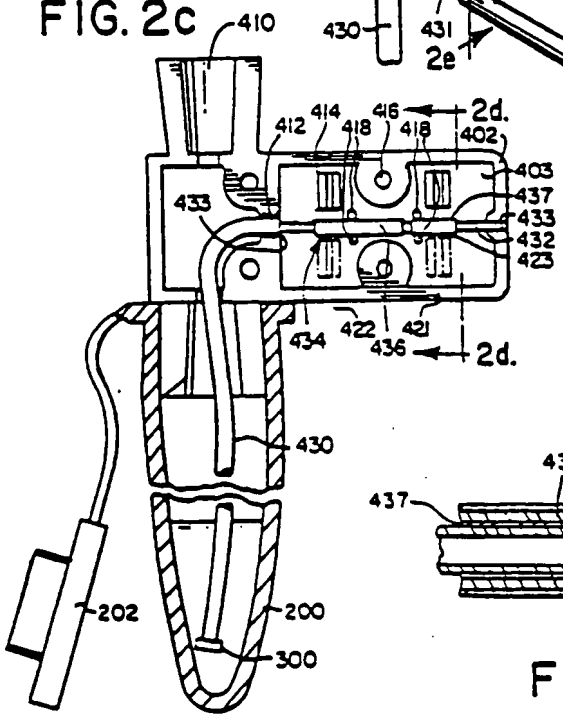


FIG. 2c

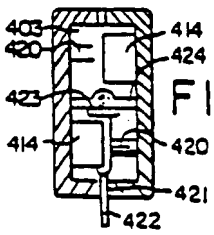


FIG. 2d

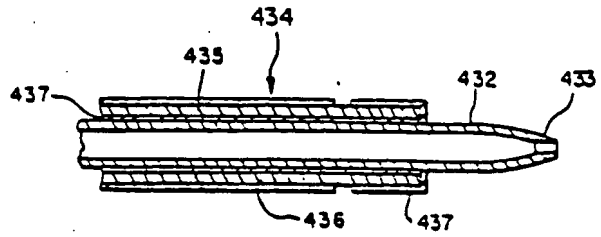


FIG. 2e

FIG. 3

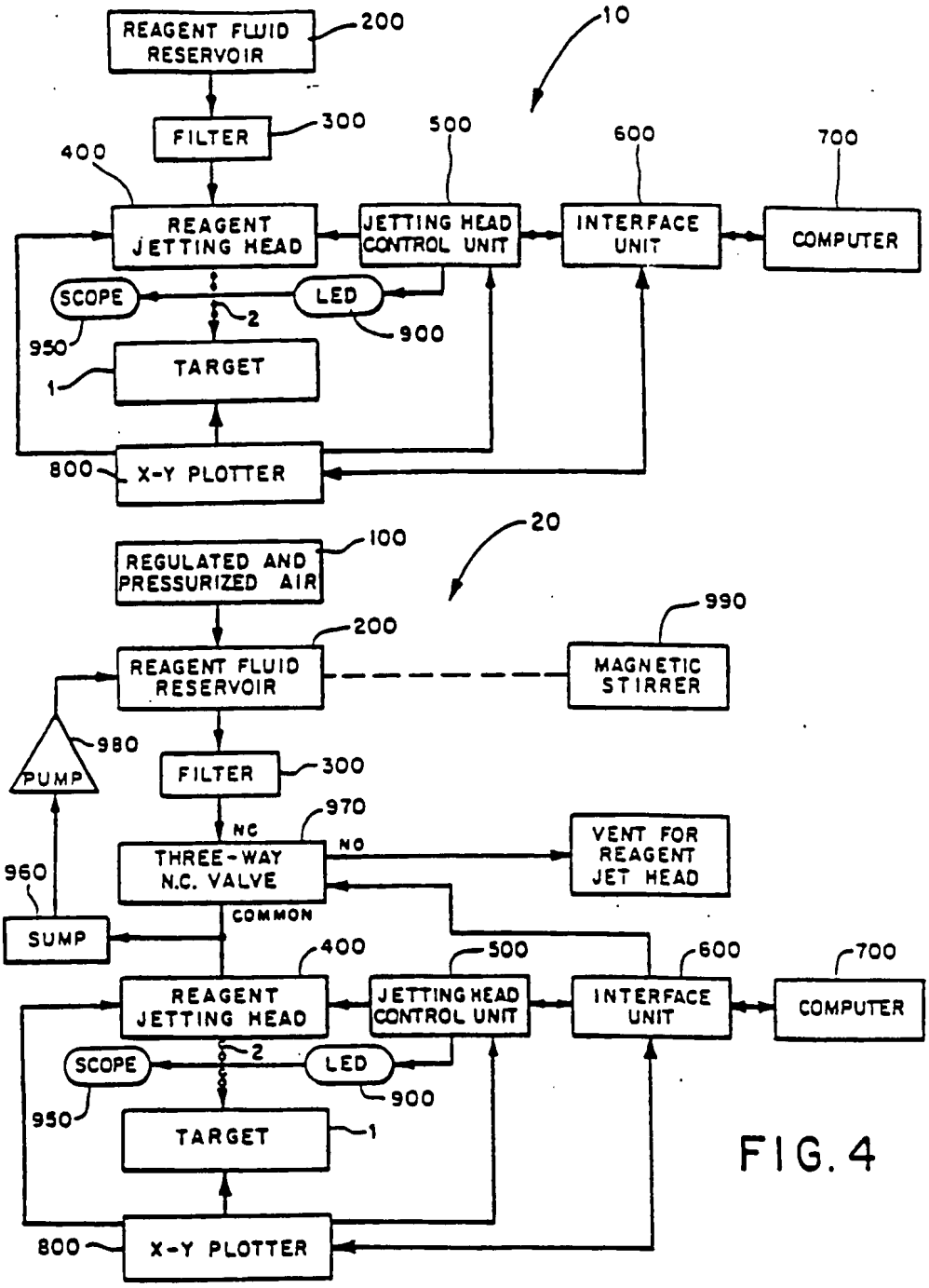

REAGENT FLUID RESERVOIR
200
10
FILTER
300
500
600
700
400
REAGENT JETTING HEAD
JETTING HEAD CONTROL UNIT
INTERFACE UNIT
COMPUTER
SCOPE
LED
2
950
900
TARGET
1
800
X-Y PLOTTER
20
REGULATED AND PRESSURIZED AIR
100
990
MAGNETIC STIRRER
980
PUMP
970
NC
NO
VENT FOR REAGENT JET HEAD
THREE-WAY N.C. VALVE
960
COMMON
SUMP

FIG. 4

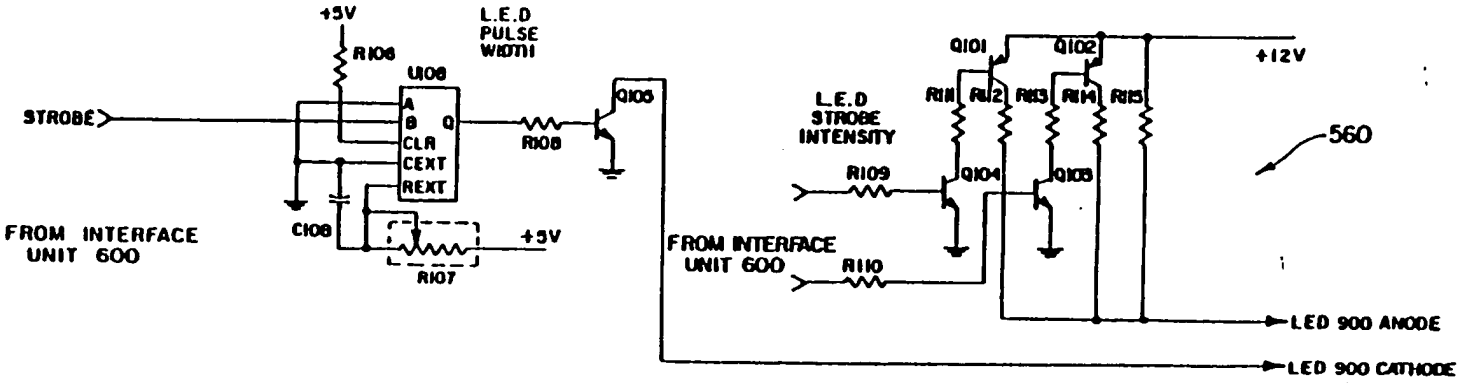

+5V
L.E.D
PULSE
WIDTH
R106
U106
A
B
Q
CLR
CEXT
REXT
STROBE
Q105
R108
C108
+5V
R107
FROM INTERFACE
UNIT 600
Q101
Q102
+12V
L.E.D
STROBE
INTENSITY
R111
R112
R113
R114
R115
560
R109
Q104
Q103
FROM INTERFACE
UNIT 600
R110
LED 900 ANODE
LED 900 CATHODE

FIG. 5a

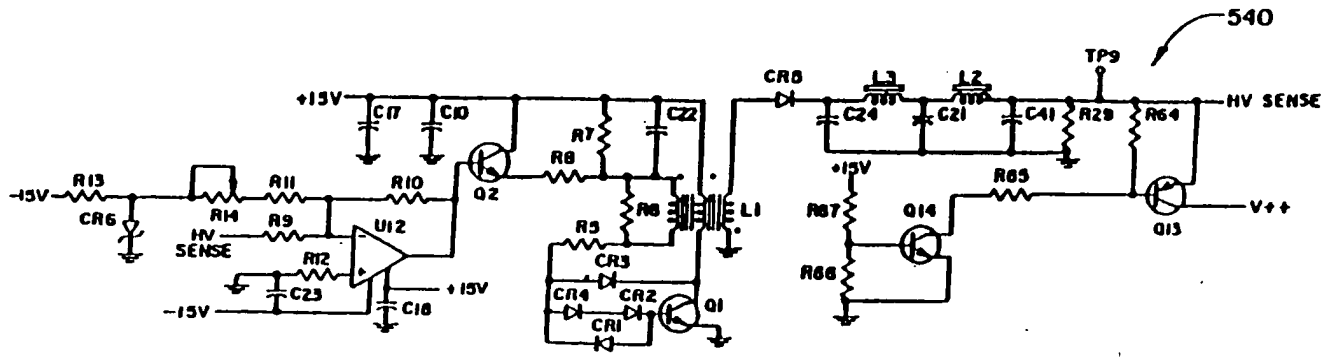

540
TP9
CR8
L3
L2
+15V
C17
C10
R7
C22
HV SENSE
C24
C21
C41
R29
R64
R8
Q2
R13
R11
R10
R65
-15V
CR6
R14
R9
HV
SENSE
U12
R8
L1
R87
Q14
Q13
V++
R5
R12
CR3
R86
C23
+15V
-15V
C18
CR4
CR2
Q1
CR1

FIG. 5b

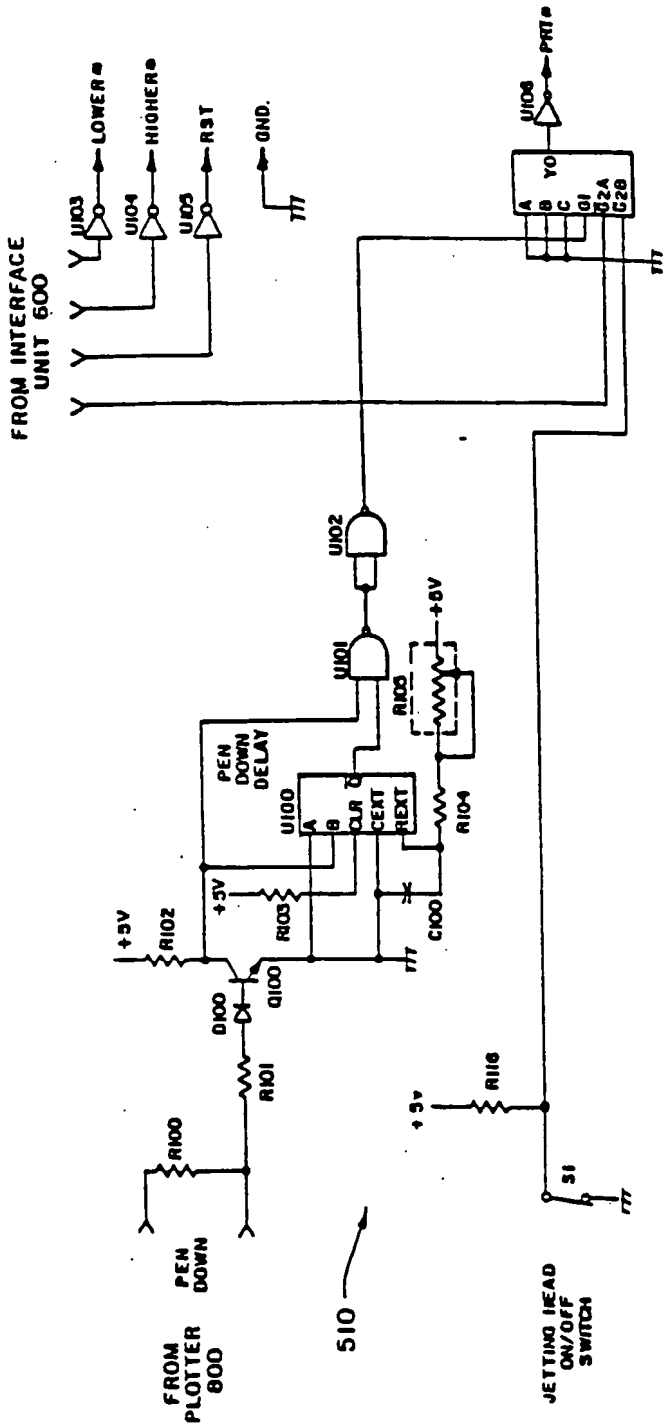

FROM INTERFACE UNIT 600
LOWER*
HIGHER*
RST
GND.
PRT*
U103
U104
U105
U106
U102
U101
U100
PEN DOWN DELAY
R105
R104
R103
R102
R101
R100
R116
C100
Q100
D100
+5V
+8V
PEN DOWN
FROM PLOTTER 800
510
JETTING HEAD ON/OFF SWITCH
S1

FIG. 5c

FIG. 5d

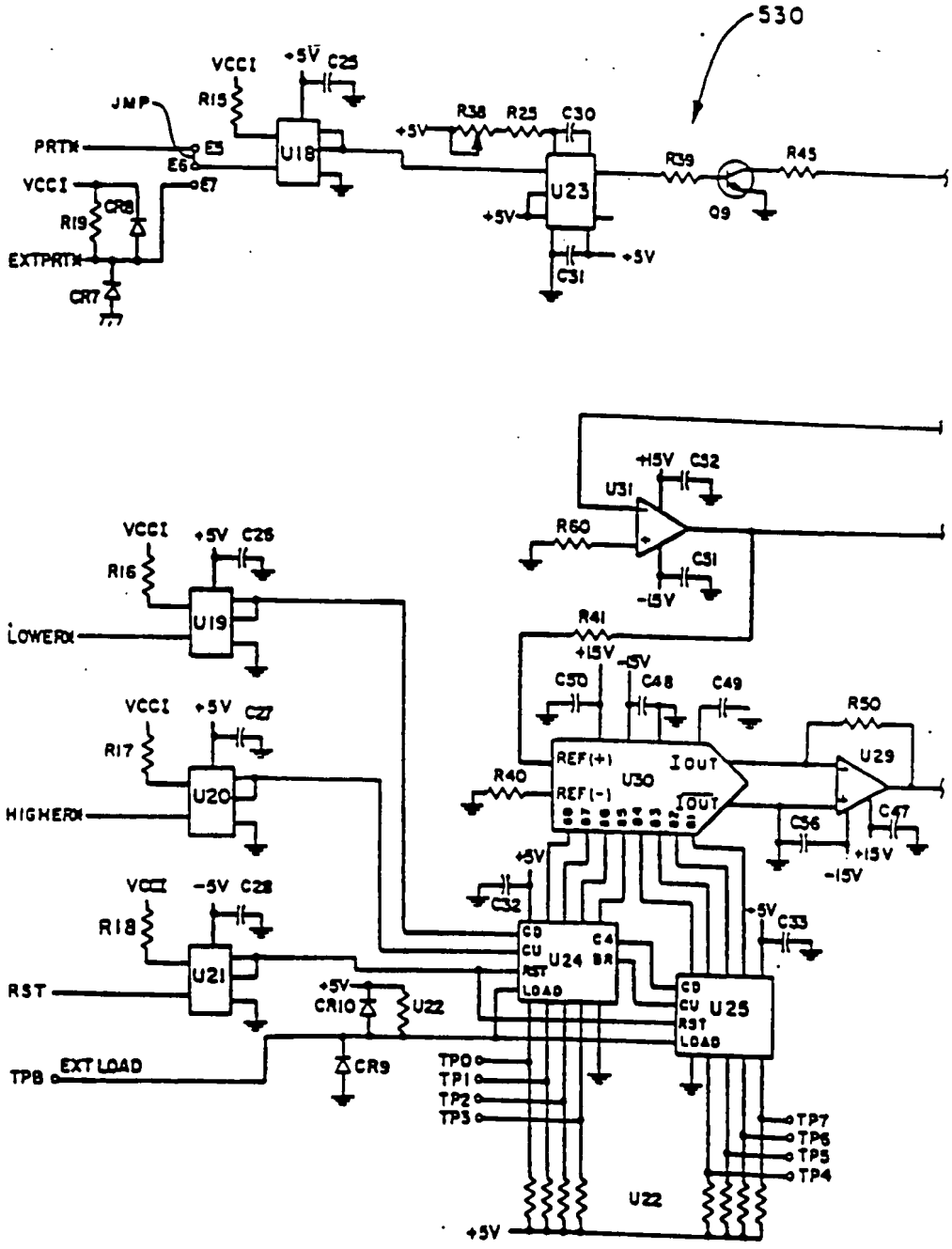

530
VCCI
+5V
C25
R15
JMP
PRTX
E5
E6
E7
U18
VCCI
R19
CR8
EXTPRTX
CR7
R38
R25
C30
+5V
U23
+5V
C31
R39
R45
Q9
+15V C32
U31
R60
C51
-15V
R41
+15V
-5V
C50
C48
C49
R50
U29
REF(+)
REF(-)
U30
IOUT
IOUT
R40
C36
C47
+15V
-15V
VCCI
+5V C26
R16
U19
LOWERX
VCCI
+5V C27
R17
U20
HIGHERX
VCCI
-5V C28
R18
U21
RST
TPB
EXT LOAD
+5V
CR10
U22
CR9
+5V
C32
+5V
C33
CD
CU
RST
LOAD
U24
BR
C4
CD
CU
RST
LOAD
U25
TP0
TP1
TP2
TP3
TP7
TP6
TP5
TP4
U22
+5V

FIG. 5e

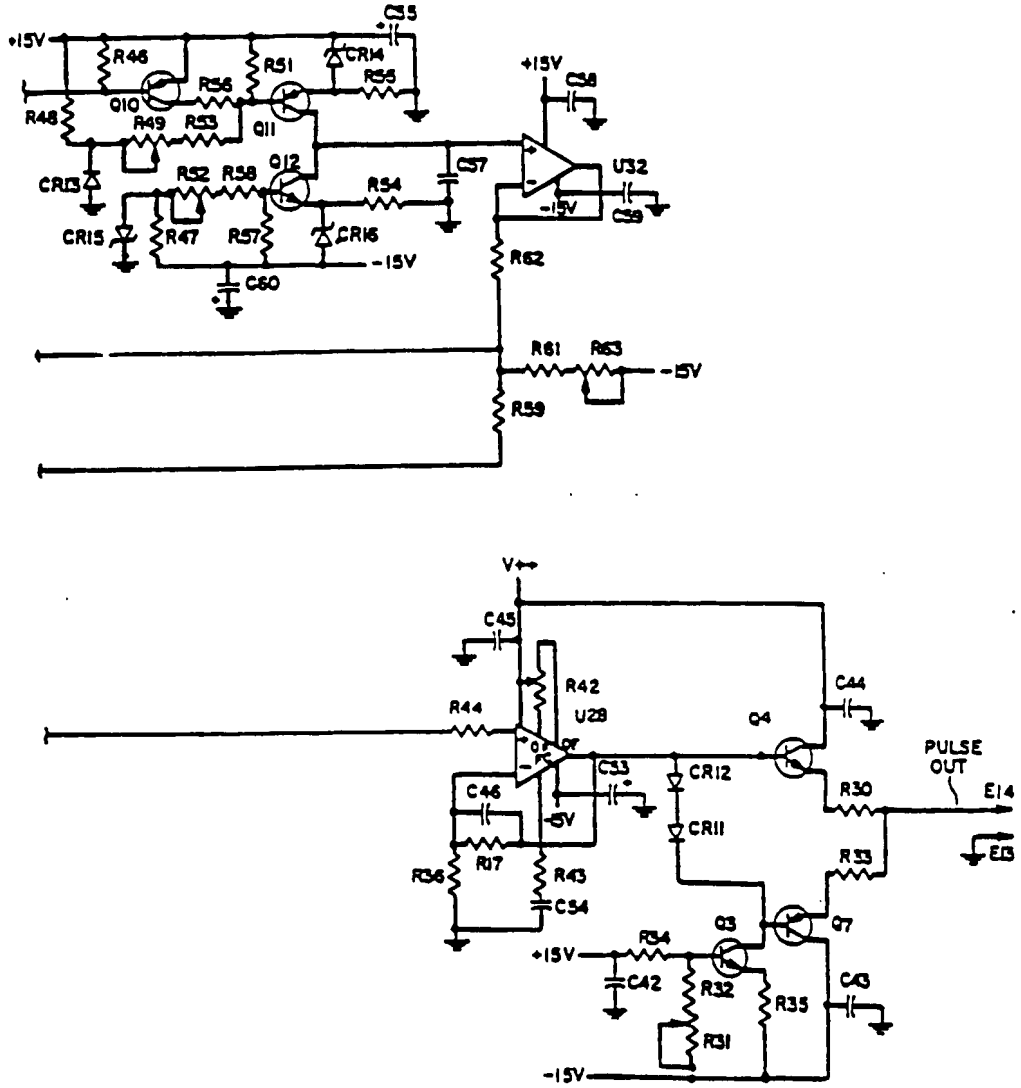

+15V
C55
R46
R51
CR14
R56
R55
Q10
R48
R49
R53
Q11
CR13
R52
R58
Q12
R54
C57
U32
+15V
C58
-15V
C59
CR15
R47
R57
CR16
-15V
C60
R62
R61
R63
-15V
R59
V
C45
R42
U28
R44
C44
Q4
PULSE OUT
E14
E13
C46
C33
CR12
R30
-5V
CR11
R36
R17
R43
C34
R33
Q3
Q7
+15V
R34
C42
R32
R35
C43
R31
-15V

FIG. 6a

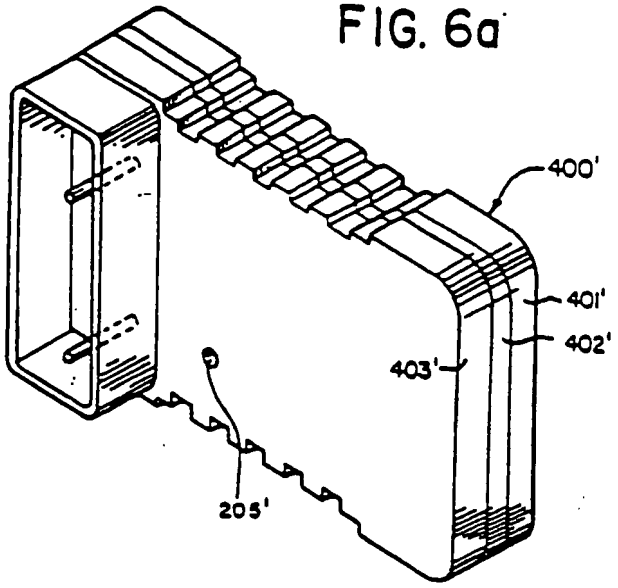


FIG. 7

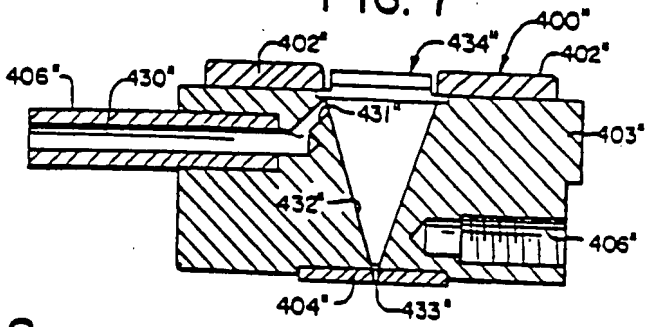
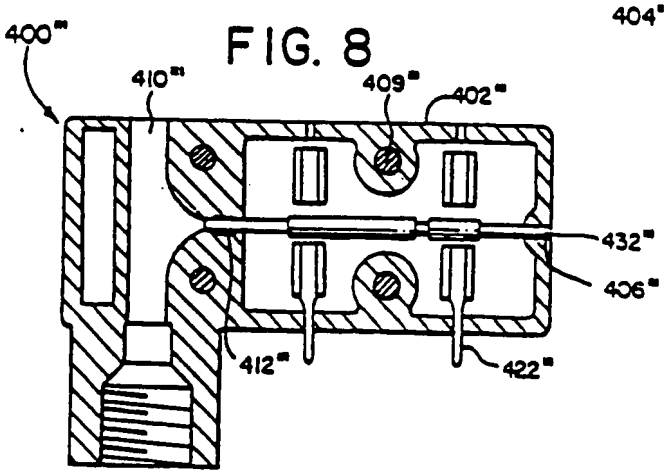


FIG. 8



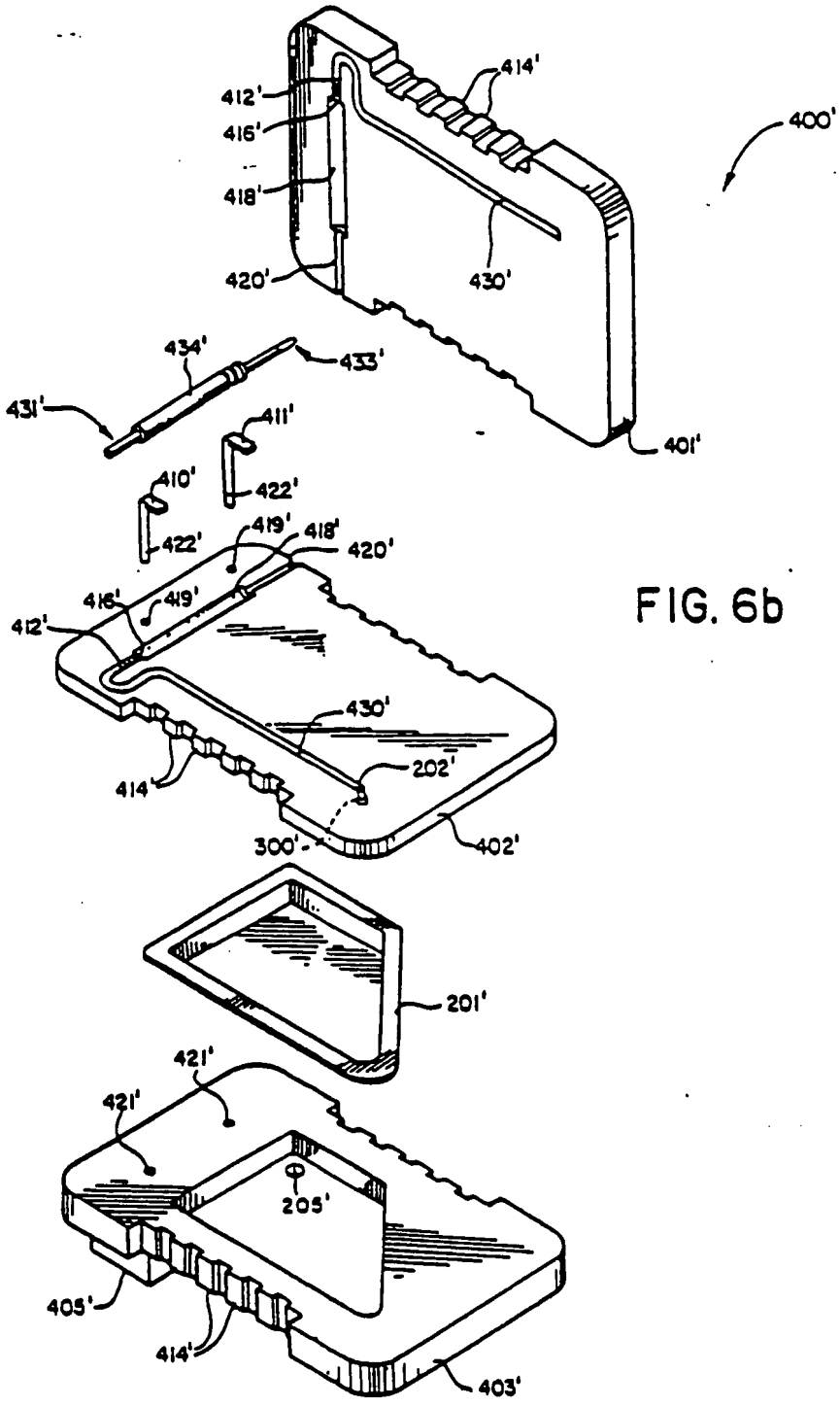

414'
412'
416'
418'
420'
430'
400'
401'
434'
433'
431'
411'
410'
422'
422'
419'
418'
420'
416'
419'
412'
430'
202'
414'
300'
402'
201'
421'
421'
205'
405'
414'
403'

FIG. 6b

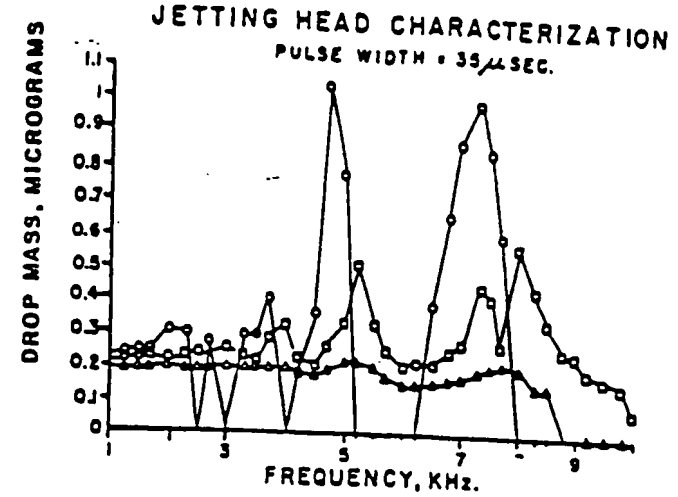


FIG. 9

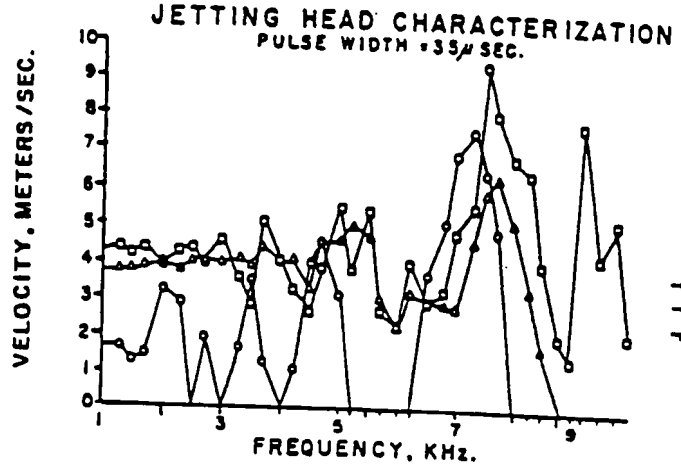


FIG. 10

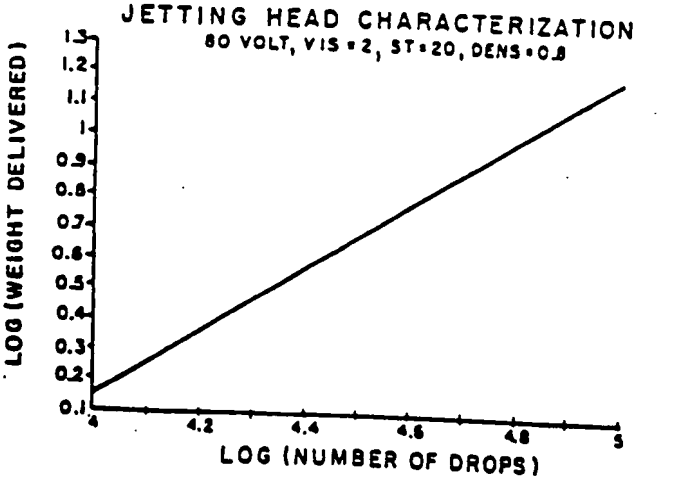


FIG. 11